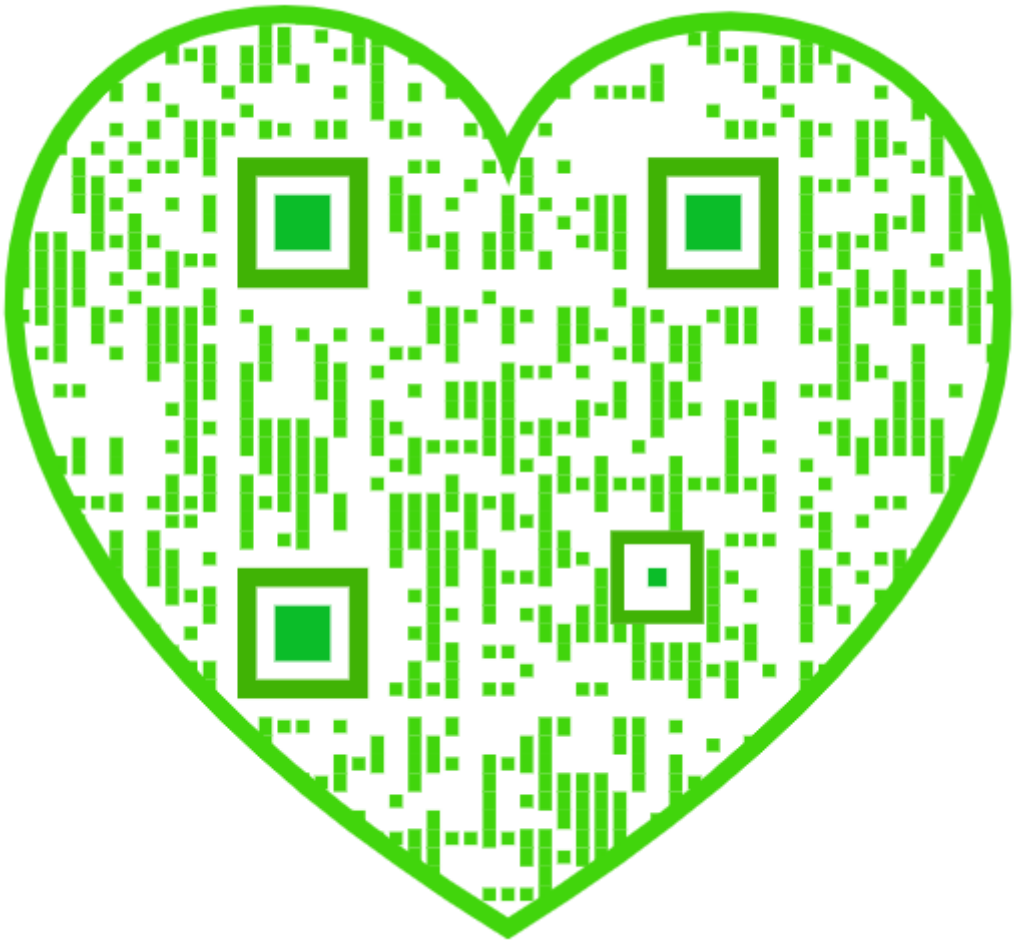

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AN ESSAY

UPON THE

Culture and Management

—OF—

FOREST TREES & NATIVE

EVERGREENS,

Exhibiting the vast amount of Timber being Consumed Here,

THE VARIOUS PROFITS AND

ADVANTAGES OF FOREST TREE CULTURE

And Directions for Planting & Cultivating the same, by

REV. GEORGE PINNEY,

Sturgeon Bay, Wis.

GALENA, ILLS.
PRESS OF D. WILMOT SCOTT,
1869.

PREFACE.

Being almost daily in receipt of letters from our numerous customers in all parts of the country, asking for information and light upon the culture of Evergreens and Forest Trees,—asking the best varieties to plant, the proper season of planting, the management and after culture and numerous other questions which it is impossible to answer in detail by letter, and at the same time keep up an extensive correspondence scattered over all the northern and western States—has induced me to attempt an answer to these questions in a brief and yet a plain scientific manner, and publish the whole in a cheap pamphlet.

So little attention, has as yet been given, to the growth and management of Forest Trees in this country, that there is a small stock of experience from which to draw information. I have sought for all the experimental knowledge within reach, and have given copious extracts from the writings of others upon the subject. No greater boon could be bestowed upon the "great west" than to reduce all horticultural operations to their first principles. But there are few persons competent to undertake the task.

These loud calls for light upon the subject demonstrate that Forest Tree culture is receiving much attention throughout the United States. In view of my conscious inability to give the subject that analysis and digest that its importance demands, it is with much timidity that I present this little work to the public, with the earnest hope that ere long as experience multiplies, and the knowledge of arboriculture increases, a better mind, more thoroughly qualified for the task, will produce a work covering the whole ground, and letting a light in upon the subject, that shall clearly point the way to unfailing success.

GEORGE PINNEY.

Sturgeon Bay, Wis., *Feb.* 15*th*, 1869.

THE GREAT
DEMAND FOR TIMBER.

CHAPTER I.

No people have equalled the Americans in boldness of enterprise and active industry. They have within a very comparatively brief period leveled the forests and let in the sun on many millions of acres, built mighty cities and formed a powerful and prosperous nation—opened canals, and sent railroads coursing through the continent, as mighty arteries through which commerce (the life-blood of the nation,) flows. Unfortunately this enterprise has not always been sufficiently guided by wisdom. The necessity for clearing off the forests, to make room for agriculture seemed to grow into a propensity for cutting and slashing, regardless of the wants of future generations.

It is my intention in this introductory chapter, to call the attention of the country, by a plain and simple presentation of important facts, and a few pointed suggestions, to a great impending national danger, beyond the power of figures to compute, and beyond the reach of language to express. I have reasons to believe that it will be long, perhaps a full century—after our children and our childrens' children have in turn toiled and labored for the boon, before the full results at which we, as a nation, ought to aim, will be fully realized by our whole country; that our production will be equal to our demands for fuel and timber. With the present outlook upon the movements of our people and nation, we can see these evils increasing upon us with a tenfold rapidity for the next thirty years to come.

The rapid disappearance of our forests, together with the vast treeless regions of the west now being opened by the great national railroad, is beginning slowly to excite the serious attention of our people.

We have noticed, on the vast prairies of Illinois and Iowa, presenting such great inducements to agriculture, with a soil of unyielding fertility, a climate scarcely second to none on earth, permeated in all directions by deep, broad rivers, capable of floating the vast commerce, and driving the manufacturer's machinery of a mighty people, with no forests to clear off, or stumps to break the furrows, a population dense, prosper-

ous and active, flow in like magic, "a nation was born in a day." We have also noticed the demand this vast population has made upon our forests. Houses and barns must be built, fuel must be had. Timber must be had for the building of their railroads and the manufacture of their agricultural machinery. Our woodlands are taxed to meet their demands, and the tax has now become exhausting. What may we expect as the results of the mighty *torrent* of emigration, that will flow along the path of the great Pacific railroad, in its march across the vast treeless regions of the western half of our great continent.

Even now, the older portions of our country are drawing their supplies of lumber from the newer States. Hundreds of millions of feet of pine are annually taken, in some instances thousands of miles, from our northern lakes and the head waters of the Mississippi, to the Atlantic and Gulf States. Michigan, Indiana and Wisconsin furnishes the Blackwalnut and many other woods now used in the manufacture of cabinet ware, waggons and machinery in the East. We are also exporting our forests to foreign countries. We send off our Oak and Pine for the purposes of house and ship carpentery. Hundreds of thousands of feet of Blackwalnut is exported for the manufacture of gun-stocks alone. This is all in addition to the demands of our Prairie States, which, because of their primitive barrenness of timber must be largely in excess of all other demands. During the past year ending January 1st, 1869, there were received in Chicago market alone one thousand millions feet of lumber; five hundred and fifty millions shingles; one hundred and fifty millions of lath, and one hundred and sixty thousand cords of wood. The average yield of pine lands is about ten thousand feet per acre and hard wood lands about twenty cords per acre. This would require for the lumber one hundred thousand acres, for the shingle fifteen thousand acres, for the lath seven thousand acres, and for the wood eight thousand acres; which would clear in the aggregate one hundred and thirty thousand acres of land of their native forests, to supply Chicago market alone.

When we consider the vast amounts that flow down the Mississippi river and its tributaries and the amount shipped to other lake ports in connection with all the foregoing the amount swells beyond comprehension.

"The great State of New York still holds pre-eminence as a lumber State; but twenty years ago it reached its maximum of ability to furnish lumber. With the enhanced price of 1860, as compared with 1850, that State produced about one million of dollars less of lumber in 1860 than in 1850; while the State during those ten years increased her population 783,341, she diminished her supply of lumber almost one million of dollars each year. Five other States in this Union also diminished their supplies of lumber during those ten years. Some of the newer States are developing their lumber interests; but our whole country (aided by foreign nations) is using up the products of their forests very rapidly.

Speaking of New York, the completion of the new railroad from Saratoga springs northwestward, called the Adirondac railroad, and traversing the vast wooded region known as the "John Brown Tract," will, a few years hence, bring a great amount of lumber into market, which has hitherto been inaccessible. But it is doubtful whether even

this will equal the amount of destruction which will, in the meantime, take place in other sections of the State. The black walnut has almost wholly disappeared from the State. The wild cherry and cucumber tree are great strangers, the hard maple and hickory in some sections are nearly gone, while entire counties, formerly heavy with hemlock and pine, can with difficulty supply now and then a farmer with a knotty sill for a small barn."—*Starr.*

In this connection we must consider the many millions of fence posts, telegraph poles and railroad ties that are taken from our forests. *I again quote Mr. Starr :*

Between 1850 and 1860 there was built in the United States 22,204 miles of new railroads. New timber was required for all these. But for nearly 8,589 miles of previously existing roads there was needed, during this period, for the replacement of old timbers, more than the amount necessary for their first construction. So that there was used in that time 65,897,020 pieces of timber, costing, at the low average of thirty-five cents a piece, $23,063,957. But, besides all this, there were building and not yet brought into use, on January 1, 1862, about 17,827 miles of new road, for all of which new sleepers were needed. When it is remembered that these sleepers are generally sound hemlock, chestnut, and especially oak; that trees are selected to make them of a size just sufficient to furnish one or two sleepers only, (the tree being simply hewn on two sides, and having the heart entire,) the destruction of choice timber just approaching a size suitable for sawing is immense.

When all this consumption is considered, the amount of land annually cleared, for lumber, timber and fuel, swells to two or three millions of acres.

The average annual increase for the last ten years has been about twenty-five per cent. At this rate of increase five or six millions of acres will be cleared during the year 1872. With this drain, how long will our timber lands last?

In considering the destruction of our forests, we must not forget the vast amounts annually cleared and the timber burned by the farmers.

From 1850 to 1860 over 80,000,000 acres of land in all parts of the Union were brought into cultivation; of which it is estimated three-fourths was timber land, making 60,000,000 acres cleared by farmers, in ten years, or 6,000,000 acres a year; on an average, this rate of clearing is no less now than then. With all this array of facts and figures, it is no exageration to say that the amount of forest destroyed during the last year was between eight and ten million of acres.

It is quite certain that the one-half of this generation cannot pass away before our forests will be so far consumed as to materially affect the prosperity of the country.

The northern parts of Michigan, Wisconsin and the John Brown or Adirondac region is now all the heavy timber districts we have left; and at the present increasing rate of consumption, fifteen years will not elapse before this supply will be exhausted. During my residence of five or six years in northern Wisconsin I can observe this havoc in all the woodlands of my acquaintance. One-half of the valuable timber standing five years ago are now swept away. In all the sections remote from a mar-

ket and where logs and lumber and firewood cannot be readily exported, however excellent the timber, the trees are slashed down and burned at once, or killed by girdling, and left to stand until overthrown by their own weight or the storms, and are then consumed by fire.

The same results are witnessed in all our timbered regions. Our forests are fading like the morning dew. The land thus stripped is usually permanently aleviated from timber growing. All arable lands once cleared of their timber are never again allowed to be overrun with forests. In fact, destructive man, so utterly robs and impoverishes the land of timber that he destroys the beauty of the landscape, and outside the fence of his "wood-lot" leaves no shade for man or beast. In their haste to get their lands under cultivation, they girdle and burn vast tracts of the most beautiful forests, while they could, with the greatest advantage to the crops, and the general health and beauty of the country have left fine belts of timber from two to eight rods wide on one or two sides of every field. So thoughtless and reckless have men been in clearing up their farms, that they have not even exercised the forethought to select the knoll, and save the forest, where they build their residences; but the spot is bared and wealth builds a large and costly house, and the old farmer, gray with age and worn with toil, begins just at the door of the grave, to enjoy the "meagre artificial shade prepared with long toil and heavy expense."

We ought in this matter, to be as willing to be profited by the history of other nations as in anything else. We study the history of the world, to gain the wisdom we need to conduct our national affairs; why not profit by the fearful record the world's history presents respecting the destruction of the forests. "Palestine and Syria, Egypt and Italy, France and Spain, have seen some of their most populous regions turned into a forsaken wilderness, their most fertile lands into arid, sandy deserts." Our beloved land, is fast hastening in the same track; and unless some immediate, well concerted action is had, THIRTY YEARS MORE will find destruction at our gates.

I quote from Hon. G. P. Marsh:

"There are parts of Asia Minor, of northern Africa, of Greece, and even of Alpine Europe, where the operation of causes set in action by man has brought the face of the earth to a desolation almost as complete as that of the moon; and though, within that brief space of time men call the "historical period," they are known to have been covered with luxuriant woods, verdant pastures, and fertile meadows, they are now too far deteriorated to be reclaimable by man; nor can they become again fitted for human use except through great geological changes, or other mysterious influences or agencies of which we have no present knowledge, and over which we have no prospective control.

"The earth is fast becoming an unfit home for its noblest inhabitant, and another era of equal human crime and human improvidence, and of like duration with that through which traces of that crime and improvidence extend, would reduce it to such a condition of impoverished productiveness, of shattered surface, of climatic excess, as to threaten the deprivation, barbarism, and, perhaps, even extinction of the species.

"The destructive changes occasioned by the agency of man upon

the flanks of the Alps, the Appenines, the Pyrenees, and other mountain ranges in central and southern Europe, and the progress of physical deterioration, have become so rapid that, in some localities, A SINGLE GENERATION HAS WITNESSED THE BEGINNING AND THE END of the melancholy revolution.

"It is certain that a desolation like that which has overwhelmed many once beautiful and fertile regions of Europe, awaits an important part of the territory of the United States, unless prompt measures are taken to check the action of destructive causes already in operation. It is in vain to expect that legislation can do anything effectual to arrest the progress of the evil, except so far as the State is still the proprietor of extensive forests. Both Clave and Dunoyer agree that the preservation of the forests in France is practicable only by their transfer to the state, which alone can protect them and secure their proper treatment. It is much to be feared that even this measure would be inadequate to save the forests of our American Union.

THE GREAT ADVANCE IN PRICE OF LUMBER AND TIMBER.

The price of lumber, timber and wood is rapidly advancing. "Among the things which are most fundamental to a nation's material growth and prosperity, we name these four—cheap bread, cheap houses, cheap fuel and cheap transportation for passengers and freight." The destruction of our forests is interfering largely with the whole of these four elements; but more particularly with the cheap houses, cheap fuel and cheap transportation. The present high price of lumber hinders the erection of dwellings. A poor man now is obliged to continue in his old log hut, laboring years longer to obtain his lumber for a house than he did ten years ago to build one equally commodious and comfortable. Years of his life are simply thrown away just to meet the evils being entailed upon us by this wholesale slaughter of our forests. Tens of thousands are thus discouraged from ever becoming freeholders. The growth of our cities is retarded by it. Substantial and costly residences would spring up instead of the small uncomfortable tenements, which, by their uncouth appearance, and liability to fire, may be almost considered a nuisance in our large cities. The expensiveness of building compels the landlord to charge higher rents, which aids to "grind the face of the poor."

In any region, hamlet, or city where fuel is dear, the want interferes with business and mars the happiness of its occupants.

The consumption of fuel in all our large cities far exceeds the production of the immediate neighborhood; it must, therefore, be brought from a distance, and the transportation, usually far in excess of the first cost, more than doubles its value. This increases the expense of every class in community; but it is more especially felt by the industrious poor. It diminishes their happiness by forcing upon them imperfect cooking, exposure to cold and damp and consumes so large a portion of their earnings that they are in a measure held back from purchasing comfortable clothing and securing for their families a home and education.

High rates of transportation result from the increased cost of building vessels and steamboats and building and equiping railroads. The material for ships and steamboats now cost fully double the expense a

few years since. The increased cost of ties in laying the track, and of lumber used in the superstructure of a railroad, for its depots, and for the cars has added much to the capital upon which they must make dividends, or the bonds upon which to pay interest; and the enhanced value of fuel also increases the expense of running the road. And this expense is rapidly increasing and these evils are becoming more and more pungent. Manufacturing establishments are not erected in hundreds of places where they otherwise would be, were it not for the high price of fuel for the engines and lumber and material to use. All these interfere very materially and palpably with the prosperity of the country.

"A nation which produces the raw material for every species of manufactures and commerce, and that at low cost—whose people provide their own houses and raise all they consume—which can move its people, its products and manufactures quickly and cheaply, is in a condition to establish the most complete division of labor, and to give to every man the results of his ability, energy and skill.

Such a nation must prosper. Its people will save and accumulate immense sums from their respective earnings."

If the present onslaught upon our forests continues, and we know it must, the foregoing evils and burdens will become insupportable.

What expedient, then, shall we resort to for procuring the materials for fencing and farm building? Where shall we obtain timber for the construction of agricultural implements, for ships and steamboats, for bridges, railroads and machinery, and the fuel necessary to keep all in motion?—to say nothing of the three or four thousand cords of wood now consumed in the dwellings in every township throughout the settled portions of the country. This question must be met during the next ten years, by the planting and growth of forest trees all over the country. The timber of the new plantation will be needed quite as soon as sufficient growth can be attained.

Horticulturists, nurserymen, and many other strong, intelligent minds are urging upon the country the importance of planting trees. This advice is being heeded in some degree. Public sentiment is beginning slowly to awake on this important subject.

There should be at least one hundred millions of forest trees planted annually upon the prairies of the west.

CHAPTER II.

THE BENEFITS THAT WILL RESULT FROM AN EXTENSIVE PLANTING OF FOREST TREES. 1*st*—*Direct income from the timber grown.*

THE RESULTS OF EXPERIMENTS.

I have no accounts of any extensive and long continued experiments on the western prairies.

The best experimental knowledge we possess is that furnished by Levi Bartlett of New Hampshire.

His experience was in New Hampshire. We must remember, that trees upon the warm rich soil of the prairies will make a much more rapid

growth. S. Edwards, of LaMoille, Ill., furnishes us with an example of a White Willow from a cutting, planted on the bank of a sod fence on the prairie, growing to three feet in diameter in sixteen years, of Poplars growing 18 feet high and 4 inches in diameter in two years from the cutting, and of White Pine making a growth of four feet in a single year.

Mr. Bartlett's experience extends over a period of fifty years, upon a tract that had been cleared of the timber and thoroughly burned over in a very dry time about the year 1800. It was immediately seeded with White and Norway Pines. In about twenty-five years Mr. B. came in possession of the tract.

He immediately thinned out the growth on about two acres, removing over one-half the number of the smallest sized trees; the fuel much more than paying the expense of clearing off. From that time nothing more was done with the lot for the next twenty-five years, having sold the lot during that time; he found, however, upon examining the lot twenty-five years later, that by a careful estimate the lot thinned was worth at least 33 per cent. more per acre than the portion left to itself. He sold the land at ten dollars per acre and it would at that time readily bring one hundred dollars per acre; he thinks that had the land been judiciously thinned out yearly, enough would have been obtained to have paid the taxes and interest on the purchase above the cost of cutting and drawing out, besides bringing the whole tract up to the value of the two acres thinned out.

At the time Mr. B. thinned out the two acres (twenty-five years from the seed,) he took a few of the longest, about eight inches on the stump and forty to fifty feet high and hewed them on one side for rafters for a shed. When he visited it twenty-five years later, (about fifty years from the seed), he with the owner estimated that had the trees been equidistant apart over the two acres, thinned out, they would stand at the distance of six to eight feet. They were mostly Norway pine, ten to twenty inches in diameter and eighty to one hundred feet high. He was greatly surprised, upon visiting the lot seven years later at the greatly increased growth of the trees, especially of the two acres thinned out thirty years before. Mr. Bartlett's own words are: "The owner had done nothing to it except occasionally cutting out a few dead trees for top poling walls. It was the opinion of both of us that the portion thinned out is now worth twice as much per acre as the part not thinned—not, however, that there is twice the amount of wood on the thinned portion, but from the extra size and length of the trees, and their enhanced value for boards, logs and timber. There are hundreds of Norway and white pine trees that could be hewn or sawed into square timber from forty to fifty feet in length, suitable for the frames of large houses, barns and other buildings. There are some dead standing trees among those which were thinned, but they are wholly the smallest sized ones that have been overgrown and shaded by the larger trees. On the part of the lot left to nature's thinning out, there are a vastly greater number of dead trees; many of them have fallen, and are now lying on the ground, and are nearly worthless. Of the dead trees standing, cords might be cut; they are well dried, and would make capital fuel. I scolded the owner for suffer-

ing such a waste of fire-wood. The trees are now about fifty-five years from the seed."

According to the preceding statement, Norway pine trees grew in fifty years from the seed eighty to one hundred feet high and ten to twenty inches diameter, and standing six to eight feet apart each way. Allowing the trees to stand eight feet each way, and to average twelve inches in diameter, eighty feet high, there would be THREE HUNDRED AND FIFTY CORDS OF WOOD PER ACRE, there being six hundred trees to the acre, and every two trees making one and one-fourth cords wood. This estimate is doubtless too high, but Mr. B. could not be so wild as to make its extravagance very great. A very liberal reduction on his estimate, at his last visit, (about fifty-five years from the seed) there would be six hundred trees per acre large enough to cut four twelve feet logs each, 12 inches in diameter, would give ONE HUNDRED AND FIFTY THOUSAND FEET LUMBER; reduce this estimate by one-third, and we have one hundred thousand feet lumber per acre in fifty-five years from the seed, and enough timber taken off annually to pay the interest on the investment, taxes and all other expenses of taking care of the woodland. If the above are not over estimated by more than one hundred per cent. it would then show big in favor of forest culture.

The ordinary yield of our timbered lands, growing in a state of nature uncared for is about twenty-five to thirty cord of woods and ten to twenty thousand feet of lumber. In these instances the growth of the timber has had to take its natural course with all the disadvantages of being too thin in some places, too thick and crowded in others, and with old and young promiscuously mixed together; and it is not at all unlikely that with the best management, whole tracts of woodlands might be reared to yield many times the amount found in the native forests, and that the estimates just made may not exceed probability.

In 1848, R. S. Fay, of Massachusetts, started a plantation of soft maple, Norway maple, rock or sugar maple, pin oak, overcup white oak, American white elm, chestnut, birch, Scotch larch, Norway spruce, Austrian pine, Scotch fir and white pine. The trees were mostly about three feet high. There was no cultivation of the soil where the trees stood and the only attention the trees received was a judicious thinning out; after fourteen years growth they were measured four feet from the ground and measured as follows: Silver maple, thirteen to fifteen inches diameter; Norway maple, eight to 11 inches; rock or sugar maples, seven to nine inches; pin oak, ten inches; overcup white oak, seven inches; white oak, six inches; American elm, from seed, ten inches; Spanish chestnut, eleven inches; canoe birch, nine inches; Scotch larch, eight to ten inches; Norway spruce, eight to ten inches; Austrian pine, eight to nine inches; Scotch fir, eight to nine inches; white pine, nine to ten inches.

Gov. Halbrook, of Vermont, furnishes the following statement of his own observations in relation to the successful growth of young timber:

"Ten years ago I cut the wood off a long stretch of side hill and in my inexperience burnt over a portion of it for pasture. The remainder was left to grow up again to wood. Many of the young trees are now

six to eight inches through; they are all very straight and thrifty. I value one acre of this land more than five acres which are in pasture. I shall not again permanently clean up my steep hillsides."

"At the solicitation of a railroad friend a short time since I accompanied him into the country to examine and estimate the value of some wood lots. I was forcibly struck with the amount of rugged, barren land, inaccessible for agricultural purposes, which had been thrown into open country, even by the present owners. Had a second growth of wood been permitted to run up on the land, instead of subjecting it to the burning and cropping process, it would have been now worth far more to the owners, for a railroad is tapping that country with its large and clamorous demands for wood and timber. Riding along with an old inhabitant of one of the towns visited, he pointed out a wood-lot which was cut over twenty years since and suffered to grow up again to wood, contrary to the usual custom. It was sold at auction a short time since for $3,400. It would not have brought over $800 had it been in pasture from the time it was cleared.

"Warm hill-sides, having an eastern or southern slope, send up a second growth of wood with great rapidity. Although they may not eventually support so heavy a growth as strong level land, they will yet produce all the wood they are capable of sustaining much sooner. A friend directed my attention the other day to a tract of land with an eastern slope in a neighboring town which was cleared of an original growth of wood twenty-five years ago, and left to itself to produce another growth from the sprout. The land, with its present standing wood, was appraised a year or two since at $50 an acre. Ten dollars an acre is all that similar land in pasture in that vicinity has ever been worth. By the application of a little arithmetic, then, we find that the increase of this second growth of wood has been equal to 16 per cent. interest per annum on the worth of the land, without a dollar's expense for the cultivation; that is, $10 at 16 per cent., simple interest, for 25 years, amounts to $40; to which add the principal, the worth of the land, and we have $50, the appraised present value per acre.

Several successful attempts have been made within my observation in improving rugged and exhausted lands by planting them out to trees. Within sight, while writing, is a knoll that has been completely renovated by a plantation of the white locust. It was originally a coarse, worthless gravel, barren of herbage of any kind. I remember that the proprietor was laughed at by his neighbors for attempting to grow trees on his barren gravel. The locust got root, however, and, although their growth was slow and feeble, they gradually formed a soil by the annual shedding of their leaves; and as the soil became thus strengthened their growth became more vigorous, new shoots sprang up in all directions from the roots, and after awhile clover and other grasses begin to appear on the open ground. I have been curious to observe the gradual improvement of this land. Last summer I noticed that the grass was very luxuriant, and would have yielded at the rate of a ton or more of hay to the acre in the open spots. The locust wonderfully endows a poor soil with new energy and fertility. It seems to make its demands for nourishment more largely upon the atmosphere than any other tree, and gains foothold in soils

absolutely barren of fertility. Then, again, its leaves are small, with very rough edges, lying perfectly still where they fall, while those of most other trees are blown about by the wind, collecting in hollows or in large heaps."

Governor Halbrook adds the experience of John Lowell. The land was a green sward that he thought needed "breaking up;" he cultivated potatoes upon it two years and then planted it with pine trees from the forest about five feet high and a few hard wood trees; acorns were planted in some places. In fourteen years he had a young, beautiful and thrifty plantation of trees, twenty-five to thirty-five feet high, and the largest, which were of pine, twelve inches in diameter. We have several accounts of the growth of forty cords of wood to the acre in ten years growth from the seed—an average of four cords per year.

Great profits can be realized by those having low swampy bottom land, especially if overflown some portion of the year, by planting larch. Larch will exceed any other forest tree of equal value for timber in the rapidity and value of its growth.

When taken in its favorite localities no other forest tree will produce as much money value in the same length of time as the larch. In rapidity of growth it is excelled by but few. Its tall, straight and symmetrical trunk is excelled by none. In five years it will attain a height of thirty feet, on its favorite moist bottom land, with a deep rich soil, and can be planted eight or ten thousand trees to the acre, and after the first five years growth ten thousand rails per acre can be taken off and leave one-half the timber still standing in rows four feet apart and two feet apart in the row. In five or six years more these will have attained a size sufficient to allow two thousand trees more per acre to be taken out, large enough to make ten thousand more rails or to work up into fence posts, small timber scantling, stove wood, &c., &c., and still leave two thousand trees standing far enough apart to allow them to attain a size sufficient to work into lumber. No other branch of agriculture will yield in fifteen years as much value per acre.

2nd—Their usefulness as screens and windbreaks in winter.

Large tracts of unbroken country over which the cutting winds of winter sweep fiercely, are injuriously affected in many ways. The snow which should form a protecting mantle, is swept off into drifts, and the bare earth subjected to the full action of the hardest frosts, rendered doubly powerful by the chilling power of the unbroken winds. Young plants of grass and winter grain, after being heaved up by intense freezing, are beaten about and often actually torn out by the power of the wind. The cattle about the farm-yard, unprotected from the wintry blasts, stand with "all fours upon a sixpense" shivering in every joint and muscle; stock thus exposed require much more food and care to bring them well through the winter. The amount of fuel required in these sections exposed to the unbroken blasts is much greater than in the shelter. The liability of both man and beast to take violent colds, from which much suffering and many mortal diseases result, is much greater when exposed to these unbroken winds than in sheltered localities.

A writer in the *Prairie Farmer*, whose enthusiastic spirit is worthy of all praise, exclaims: Who can compute the amount of winter grain,

of fruit, of tender shrubs, destroyed by the intensely cold sweeping blasts which rave over the prairies of Illinois? The question comes home to all the residents of such districts: Can nothing be done to soften the rigor of such sweeping storms? Yes; stud these prairies with belts and groves, with screens of evergreens and deciduous trees. Plant the railroads and highways with rapidly-growing trees, in double or treble rows, upon the sides from which drifting snows accumulate, and carefully attend to them after planting. The money spent in clearing and keeping clear, the tracks during a heavy storm, upon one of the western railroads, would have purchased trees or cuttings sufficient to have planted the entire line of road, which, in four or five years, would have grown to a perfect barrier against accumulating snow-drifts. The benefit arising from planting trees would not stop with the saving of money to the corporations, and with the saving of life and suffering to the people. The crops would be increased in certainty and amount, the health-giving fruits secured to us, domestic animals made comfortable and thrifty, and the surface of the country would become beautiful beyond conception. Do not forget the lesson the extreme storms of cold should teach us. Let tree-planting go on henceforth with renewed earnestness and care, and anon we may laugh at the elements, and point with pride to the wonderful transformation the human hand has accomplished.

3rd—Their benefits to Orchards and Crops during the summer and growing season.

The attention of the farmer is more closely given to the protection afforded by the forests during the winter, than the summer; but experience has shown that summer protection to orchards and crops is far more important and requisite.

The destructive blighting which results from the rapid drying of the absorbing currents of westerly winds, relieved of all their humidity by the condensing power of the snow capped rocky range, and consequent sudden depression of temperature.

My experience in Ohio, my native State, is to the effect that orchards protected on the northerly sides will be more sure to produce an abundant crop of fine fruit. The "old orchard" on my grandfather's farm, now over sixty years from the seed, was at first protected by a native forest on the north, and bore abundantly, after which the forest was cut down, and several fruitless years followed. The old wood-lot was allowed to grow up with a second growth of timber; the "old orchard" come again into bearing, and at my last information was yielding an abundance of fine fruit. In general, the orchards throughout Ohio do not produce fine fruit; while twenty-five or thirty years ago, before the forests were so fully swept away, a failure to reap a rich harvest of fine fruit was not known.

The lamented Dr. Peticolis, a devoted pomologist of Ohio, justly remarks, without seeming to appreciate the great cause of the failure:

Out of one hundred and twenty or one hundred and thirty varieties of apple trees in bearing, it is difficult to select six kinds of good merchantable winter apples, because the product is not perfect, though it may be abundant. This imperfection is caused by the never-failing mildew or scab to which our apples are subject. Although some seasons are

not quite as bad as others, still one-half or more, as a general rule are unfit for market, and it is really humiliating to think that we who, a few years ago boasted of the superiority of our fruit as compared with that of our eastern friends, (of western New York,) should now be obliged to acknowledge that they surpass us. Now, why is this? Why should such a change have taken place? No such alteration, that I am aware of, has taken place in the east; their apples are as fair and as good now as they were twenty or thirty years ago. Some of our varieties are less prolific than they were fifteen years ago. Rambos then bore, at seven years old, ten bushels of good fruit, but since have never borne over four or five, even in the most favorable seasons, and these but inferior fruit. Redstreaks, the same time and age, bore thirteen bushels, but have never in any season since borne more than three or four of comparatively poor fruit. Nor can this change be attributed to the age of the tree, for trees of nearly all ages, of the same varieties, were nearly as unproductive. The white Belleflour was formerly one of the finest and best apples, but can no longer be realized as the same, being now so knotty and scabby, and producing but one-fourth of its former yield. The White Pearmain was another of the best keeping and finest dessert apples, but it no longer is even fit to look at, being perfectly disfigured with the scab. Most of the others were in the same condition.

Our desponding pomologist does not seem to understand the real evil.

We are well aware that the American climate, particularly over a greater portion of the continent, is especially favorable to the production of fruits. Neither can we shut our eyes to the fact, that throughout many of the older portions of the country it is now of rare occurrence to find an orchard producing fruit not more or less imperfect. Apples are disfigured, warty and scabby; pears are cracked, woody and worthless; and peach trees are seldom allowed to even come into bearing. Blights, so called, are very common.

We are also cognizant of the fact that in sheltered city gardens, vegetation commences at an earlier period, and as a consequence, fruits ripen earlier and in many instances attain a greater degree of perfection, and are less liable to casualties and diseases than those in the open unprotected country. All have heard of the fine butter-pears that Isaac Baxter, of Philadelphia, grows yearly upon trees protected by brick and mortar. A gardener in the city of Camden, New Jersey, has surrounded his grounds with a very high board fence, produces pears upon his dwarf trees greatly exceeding any raised by his neighbors in their exposed localities. Smooth and beautiful fruits grow upon his trees, while theirs is knotty, gnarled and worthless, because exposed to the pelting northeasters, or the biting and drying winds of the northwest, with its keen and eager airs.

All these circumstances combined, conspire to show conclusively, that the failure of fruit may be mainly attributed to the want of shelter.

These drying winds suck the moisture from everything they come in contact with, and this evaporation is increased in a prodigiously rapid ratio, with the velocity of the winds; no doubt but the pear-blight is

produced by their sucking the sap from the young and tender leaves, just as they are putting forth.

The debilitating effects of these drying winds in summer is well known without really or fully understanding the source of the aridity; but experience shows that timber belts and screens are the most effectual and at the same time the most available means of checking these drying winds.

4th—They tend to produce a greater degree of atmospheric humidity and consequently a more regular supply of rain.

There appears to be no room to doubt, that greater dryness of the air is a result of the removal of the forests, and that the earth then ceases to be equally moist, or the springs to furnish an equal quantity of water. It is the experience of ages in various countries that the presence of forests really makes the climate comparatively wet and then removal makes it dry. It is not conceivable that they do this by absorbing vapor from the atmosphere, converting it into water, conveying it to their roots and thus furnishing a supply to the ground; for this would make the atmosphere dryer, but it is known that their presence makes it more moist. If forests do increase the moisture of the atmosphere and cause the springs to flow more abundantly, it can only be by causing more rain to fall. The progressive diminution of water in our streams and ponds is known to be closely connected with the removal of our trees. It has also been observed that thorough underdraining has, in a great measure, in many localities, restored in a great measure, failing springs. The rapid evaporation from the surface, by the action of the unbroken drying winds has in a great measure been checked, by facilitating the gradual descent and withdrawal of water from below.

Underdraining is chiefly applied to lands formerly marshy or wet, holding water near the surface, such localities usually being the feeders of springs.

I here present an extract from J. S. Lippencott illustrating the action of forests in production of moisture and rain.

The increased facilities for drying the soil existing in an open, cleared, level, cultivated country, become apparent on comparing the amount of water evaporated with the rain-fall at Haddenfield in 1864 and 1865, and with similar results, determined as correct, from actual measurements made near the headwaters of Anthony's creek, a tributary of Green Brier creek, an affluent of the Kanawha river. The discharge of this creek, of which the area of drainage was carefully surveyed, was ascertained, by daily measurements for one year, to amount to 70 per cent. of the rain-fall, and 65½ per cent. of the average fall for five consecutive years.* The waters thus hastened off by the sloping mountain sides, or sunken among the leaves or into the soil or rocky crevices, and sheltered from evaporation by forests, restore a much larger proportion of the rain to the rivers directly. In this section, as generally in an open champaign country, where dry rain winds prevail and much land is exposed by tillage, evaporation may take place to the extent of three-fourths of the rain-fall throughout the year, or more than twice that fall for an entire summer. Hence the value of forests, as arresters of evaporation, or as barriers against the sweep of drying winds, becomes obvious.

Many well attested instances of local change of climate and in the even and regular supply of rain referred to the influence of forests might be cited. We give one other extract taken from the Philadelphia *Inquirer*, May 17, 1866:

While we write, it is announced in the daily papers that the inhabitants of the Cape Verde islands are again in distress from famine through the lack of rain. Having destroyed their forests they suffer terribly from periodical droughts. From 1830 to 1833 no rain is said to have fallen, and 30,000 people perished, or more than one-third of the population. Though it has been proposed to replant the forests, such is the ignorance and indolence of the people that little has been done toward restoration.

That forests do exert a marked influence upon the quantity of rain is a fact well understood by meteorologists.

The action of forests in adding to the rain-fall, appears to be due to their offering an obstruction to the free flow of currents loaded with vapor, and the upward tendency such obstructions give to the air, by which it is piled up and retarded until accumulated at sufficiently high elevations to induce condensation into clouds and rain. This is one of the regular effects of mountain ridges, and any cause which shall, in like manner, force the air to rise in any particular locality may produce a similar result. The friction against the surface of the level earth impedes the free motion of air or winds, and that which follows tends to pile upon the back of that resting on the earth, and that behind to climb still higher. If, then, the impediment of a dense forest be added to the obstruction already existing to free motion, the ascent of the strata of air will increase according to the force of the wind bearing vapor with it. When this storm encounters a forest, the resistance must be materially augmented, and the retardation of the strata becomes greater, the overlapping and ascent of the current increased, more abundant condensation takes place, and more rain falls, and the district thus becomes more wet than it would have been had the bare ground alone been left to retard the progress of the lower portions of the wind. Forests, therefore, cause the surface currents to rise higher upon their sides, as up an inclined plane, and to attain a great height, thereby affecting a district as would mountains of moderate elevation.—*Hopkin's Meteorological Essays.*

5th—Their effect in ameliorating sudden changes of temperature.

A slight reference to a few of the well known principles of caloric, will open this section very clearly. The heat or warmth upon the earth's surface is entirely drawn from the sun. In the conversion of water into vapor or steam, a large amount of heat is consumed, or becomes latent; in other words the evaporation of water is a cooling process. This is a well known fact. The laborer knows that when he sweats profusely, he can stand the heat much better, than when he is unable to sweat at all; this is because the evaporation of the sweat cools his heated body. Hence any wet body exposed to the sun is less effected by the heat than one perfectly dry: this may be illustrated by wetting one hand and holding both up to the sun, in a slight current of air, the wet hand will be found to grow cold rapidly, while the dry one will feel quite sensibly the warmth of the sun. Again, a portion of perfectly dry air will absorb moist-

ure, (evaporated water) very rapidly, but as the air becomes more and more charged with the moisture it will evaporate with less and less facility until it ceases to evaporate at all. Clothes, or any wet substance, will dry much more rapidly in the wind than in a calm; and every farmer knows how refreshing a breeze is to a man laboring and sweating in a hot day. This is because the atmosphere next the body is being changed as fast as it becomes saturated with moisture, and a more rapid evaporation is the consequence.

The great cooling process is radiation, which, under the vibratory theory is giving off vibrations of heat in every direction from the heated body. Radiation is caused by a constant tendency for an equilibrium of the temperature of all bodies, and also a constant radiation into space. The reason or occasion of this constant radiation into space has never been satisfactorily settled among philosophers. It is pretty well settled that intense cold reigns supreme in all the vast regions of space beyond the atmosphere of the planets; and it may be this tension for an equilibrium, that draws radiation into space. The vibrations are sent off in straight lines from the heated body, and continue to be given off in every direction until every object in their path is heated to a temperature equal to the body giving off heat. No body or substance is heated by these vibrations except it intercepts or destroy those vibrations. Pure dry air does not obstruct radiation sufficiently to become sensibly heated by radiation alone; but air charged with moisture does obstruct this radiation and becomes heated; and the greater the amount of moisture in the air the greater the obstruction, and the sooner does it attain the same temperature of the radiating substance.

Another ruling process is conduction or the passage of heat from one particle to another of the conducting medium; but as neither dry or moist air are conductors of heat, it is unnecessary to notice it here. The air is heated only by the immediate contacts of its particles. As the rays of heat from the sun do not heat the atmosphere in their passage, through it, it follows that the air is heated only by immediate contact with the earth; and, as soon as the particles of air in immediate contact with the earth became of equal temperature with the earth, the cooling of the earth by conduction would cease, were not these heated particles removed and other colder particles brought into contact.

It is well known that the atmosphere becomes lighter as its temperature increases, hence the warmer particles, if unobstructed, rise and are replaced by other colder particles.

By reference to these few simple principles of philosophy it will be seen that there is but one source of heat, on the earth's surface,—the sun; and three great means of counteracting the heating effect of the sun,—absorption by vaporization, radiation and conduction.

In the preceding section we have seen that forests are productive of an increased and more regular supply of rain, and that vegetation, especially fruits, flourish more vigorously in their vicinity, consequently the atmosphere in such locations contains a greater and more regular supply of moisture.

With these well known principles before our eyes it is easy to see the powerful influence that forests have upon climate. The vibratory

theory has brought to light the facts that rays of heat of low intensity, such as are given off by the soil and plants, cannot be radiated, through aqueous vapor to any extent—hence the heat of the earth cannot be radiated or projected toward the sky by night, they being all absorbed by the vapor contained in the air. Prof. Tyndall calculates that of the heat radiated from the earth's surface warmed by the sun's rays, one tenth at least is absorbed by the vapor within ten feet of the surface in ordinary moist regions; he says also: "The removal for a single summer night of the aqueous vapor from the atmosphere that covers England, would be attended by the destruction of every plant, which a freezing temperature would kill. In short, it may be safely predicted that whenever the air is dry the daily thermometric range or the difference between the extremes of heat and cold, will be very great."

R. Russell says in the Smithsonian report of 1854: The influences of moisture in tempering the sun's rays is a remarkable fact and well worthy of further investigation. When the dew-point is high, or the air is filled with moisture, radiation from the earth is prevented and the temperature of the night remains almost as high as that of the day. When the dew-point is low, the sun's rays pass without absorption to the earth, and impart little of their heat directly to the air. The medium dew-points are therefore most favorable to extreme heat in the atmosphere, and the greater heat beyond the tropics is probably owing to this cause. The fact that the amount of moisture in the air regulates the temperature of the nights has not received the attention it deserves.

Travelers in all parts of the world tell us of the connection between dry air and extreme heat by day and cold at night. On the desert of Sahara where "the soil is fire and the wind is flame," it is very cold at night, sometimes forming ice. While on the contrary beneath the tropics of America, where there is the most dense and luxuriant forests the world affords, the temperature of the day and the night remain nearly uniform, seldom rising above 80 ° or falls below 50 °; while in the treeless and consequently dry regions of the west, Capt. Beckwith says: "We observed the greatest contrasts between the heat of the day and of the night, in these mountain valleys," (upon the route of the Pacific railroad) from noon to 3 p. m., the thermometer standing at 87 ° to 90 °, and at night falling below the freezing point.

Col. Emory, in his reconnoissances of California says: On the 23d of October we retired with the thermometer at 70 °, and awakened in the morning shivering, with the mercury marking 25 °, notwithstanding our blankets were as dry as if we had slept in a house.

Daniel, in his Meteorological Essays furnishes us several examples right in point, which I quote:

Mr. Inglis, in his travels through Spain, relates that he was oppressed by the hot rays of the sun in the valley of Grenada while the hoar frost was lying white in the shade. Eastern travelers in the desert often complain of the broiling heat of the air during the day, and of its chill temperature at night. Beautiful allusions to the same law are also found in scripture, where it is related that one of the greatest hardships which Jacob experienced while tending the flocks of Laban, was that through the "drought by day and the frost by night, sleep departed from his eyes."

These conclusions are confirmed by recent travelers in a remarkable manner. We need no longer doubt the stories of Captains Riley and Paddock, as told in their once incredible narratives, when they relate that the intense heat of the sun had scorched and blistered their bodies and limbs, so that they were covered with sores, * * * while as soon as the burning sun had sunk beneath the horizon, the fresh wind cooled the earth, which became even cold before dark, * * * to be followed by fierce and chilling blasts of wind.

The experience of Captain Sabine, made on the coast of Africa, show that while the sea breeze was blowing upon his station, the hydrometer denoted the dew-point to be about 60°; but when the wind blew strong from the land, it sunk to 37½°, the temperature of the air being 66°. Notwithstanding the heat of the evaporating surface of the Sahara, the burning sands of the desert yield so little vapor that there does not exist in the winds wafted to the coast, and which constitute the true harmattan, a greater force of vapor than that which rests upon the Polar seas, for at both places the constituent temperature of the vapor, or the point of deposition, is below 32°. The sea breeze above referred to contained eighty per cent. of relative humidity, the land breeze from the Sahara less than twenty per cent. of the same.

These sudden changes of temperature are a great evil and can only be remedied by an extensive and systematic planting of forest trees.

Not that forests increase or diminish the mean temperature. Mr. Becquerel has made in the Jardin des Plantes, with a sensitive thermometer, certain observations at different hours of the day, by comparison of which it was found that about 3 P. M., when the temperature is highest, the difference sometimes amounted to 2° or 3° in favor of the atmosphere above the tree, whilst at sunrise, after a clear night, the excess was on the other side, on account of the nocturnal radiation. This experiment proves the cooling of trees and the atmosphere surrounding them under the influence of nocturnal radiation. Vegetables near a wood are sooner affected by spring frosts and the cold of autumn than vegetables at a distance from them. Under the influence of solar radiation above the trees, there is a current of warm air ascending during the night, and in the morning a current of cold descends to cool the soil. When the sky is cloudy these differences of temperature are very small. These experiments of M. Becquerel also prove the correctness of the conclusions of Humboldt from the observations upon the temperature observed at thirty-five stations in North America, extending over 40° in longitude, namely, that the mean annual temperature over this extent of country has not been sensibly changed by the great destruction of wood which has taken place during the time of the observations.

Their effect is simply to equalize the temperature. The day time is rendered cooler by the continual absorption of the heat of the sun in evaporating the increased amount of moisture and the removal of this moist air is prevented by the forests acting as windbreaks or screens. The rapid cooling at night is prevented by the vapors with which the atmosphere is charged.

A systematic planting of forest trees, especially evergreens, in dense belts, along the westerly and northwesterly sides of the fields and farms,

throughout the vast western prairies, will not only affect the climate directly as above, but will in a great measure destroy the drying and consequent cooling effects of the westerly winds, so prevalent, which have lost all their moisture in passing the treeless mountainous regions of our "Great American Deserts."

Now, let us ask ourselves what are the causes operating around or above us, producing excessive dryness in our atmosphere and in the soil? A west or northwest wind is undoubtedly a cause, largely, if not wholly, competent to reduce the amount of vapor in the air, and to render it incapable of preventing the escape of heat absolved by the earth during the day. We know that the winds which are flowing towards the northeast from the regions of the tropics, part with their moisture in rains and showers over the temperate districts. We know that on the Pacific coast the prevalence of westerly winds give a great uniformity to the temperature, and that most of the rains come from that quarter; that the cloud-bearing winds, by passing up the slopes of the Rocky mountains, lose their moisture by condensation into clouds and deposition as rain and snow, so that as they pass eastward they are dry winds, and must so continue over the vast desert region, arid and waste, which extends from the mountains on the west to the borders of the Mississippi valley on the east. These conclusions seem so well established, that it has been well remarked of the northern Atlantic States, says Robert Russell, "So long as the westerly winds continue to blow in winter, there is no cessation of your cold; and so long as they continue to blow in a broad, regular stream in summer, there is no end to your drought."—*Smithsonian Report*, 1854.

The necessity for this protection is not confined to prairie districts alone, but the timbered portion of the country are likewise suffering. "We have been reckless in using the gifts of Providence to our fathers. We have razed with ruthless hands the forests which were both ornaments of our region and the safeguard from the ravages of drouth and cold. The truest wisdom may be learned in the school of nature, and it is only as man imitates the plans of the Creator that he can hope to prosper."

6th—The very make of our country demands extensive Forest Tree Planting in the West.

Upon this point I shall extract largely from Mr. Starr:

Geographers, by an averaging of the coast and boundary lines of the United States, have fixed its geographical centre in the State of Kansas, about twenty-five miles west by six miles south of the city of Leavenworth. This is the real centre, though far too much to the west for the probable centre of population. The thermometrical observations taken for many years at Cantonment, Leavenworth (while that was still "Indian" and then "Nebraska" Territory) showed "that Fort Leavenworth was subjected, beyond any other part of the United States where similar observations were made, to sudden and extreme changes, both of heat and cold, of moisture and drought." (Authority of Major E. D. Ogden, U. S. A., 1854.) Since the settlement of Kansas the terrible droughts experienced, and the many men who have perished with the cold on the plains between Leavenworth and Salt Lake, bear evidence to the truth of the observations.

An entire absence of moisture seems to characterize the prevailing westerly winds through nearly all the vast regions west of this centre. Mr. Starr goes on to say:

And this is to be expected in the nature of things. There is no body of water in the centre part of the North American continent, west of the Mississippi river, which is able to exert any controlling influence upon the temperature of all that region. When we go north from Fort Leavenworth five degrees we are in a cold and frozen climate, closed early in the fall and locked in frost until late in the spring. Pass five degrees southward, and you have almost forsaken the region where ice may be said to form; hence this middle ground is wholly controlled by the prevailing type of the season, interspersed with the sudden and ofttimes violent interjection of short periods of temperature from the opposite points of the compass. Thus the general winter may be mild, without snow, with scarcely frost enough to prevent ploughing a single week through the entire winter, and there may come one, two, or five days, when the thermometer shall stand anywhere from zero to 26° below zero. On the other hand, in a long, cold, snowy winter, a period of very spring or early summer, as regards its balmliness and comfort, may break in with equal suddenness. The same latitude upon either the Atlantic or Pacific coast is no criterion by which to judge of the temperature of the plains. The presence of a great ocean, with its broad, open bosom continually exposing to the biting air the fresh warm currents of her inmost being, gives a stability and produces a control over the temperature which is unknown when we reach a point almost two thousand miles from each ocean, and one thousand from the Gulf of Mexico. No portion of the world more needs the presence of great and numerous forests to preserve an equilibrium of temperature than the central parts of North America, and especially upon this latitude, which, as it approaches either ocean, is so admirable and so much sought for.

The same causes which produces such instability of temperature have an almost equal and direct effect upon the amount of moisture in the atmosphere. The depth of the Missouri and Mississippi are insufficient to produce much effect upon temperature by their simple, positive presence; the results which are obtained come rather from the processes of evaporation. I suppose that were the Missouri river, from its mouth to the headwaters of the Yellowstone, to be laid out in a straight line, and its tributaries to be laid on each side of it, side by side, that the surface of that mighty river would average a mile in width by three thousand in length, giving an evaporating surface of 3,000 square miles. When we remember that the Missouri river discharges all the water east of the Rocky mountains north of the Arkansas headwaters, except what is carried by the St. Peter's and the Des Moines into the Mississippi, it will be seen that a little lake, sixty miles long and fifty wide, is not a large surface from which to *evaporate* water in so vast a territory.

As these westerly winds move eastward, they become again charged with moisture drawn from the streams, and increasing forests and vegetation, together with the great western lakes.

Having now presented many of the incentives and advantages of planting forest trees, we come to the subject of propagating:

Forest trees can be propagated either by planting the seed, by cuttings, or by transplanting from the native forests. All varieties may, with a knowledge of the subject and proper care, be started from the seed; but few, comparatively, can be started from the cuttings. All may be successfully transplanted from their native forests.

All labor and expense of transplanting would be considerable on an extensive scale, and as some kinds of trees are difficult to transplant successfully, such, for example as the chestnut, hickory and tulip tree, it has been found cheaper and better to plant the seeds where the trees are to remain, and in two years remove every alternate plant, and transplant on another portion of the plantation, and in three or four years later every alternate row.

But the raising of forest trees, especially evergreens, from the seed, is a tedious operation—few but professional nurserymen either know how to do it successfully, or are willing to bestow the requisite amount of care and attention.

Starting from cuttings is also an uncertain operation. But few varieties will start from the cuttings. It is quite impossible to start an evergreen, or any variety of tree possessing a resinous sap from the cutting.

Transplanting then is the only method of starting a forest tree plantation worthy of universal commendation. I will, however, devote a few pages to propagating from the seed.

PLANTING SEED.

Nature teaches the best lessons in planting seeds of her spontaneous productions. In studying the proper condition of the seed, the nature and condition of the soil in which to plant, and the time of planting forest tree seeds, the best text books are the forests themselves. From them we learn that the proper time for planting is just the time nature does her planting, and the proper condition of the seed is the exact condition we find the seed in when dropped from the tree. The particular time of dropping the seed is not so essential as the particular condition of the seed. If all other conditions and circumstances are right in every particular the time of planting is not important. The condition of the seed is liable to change after dropping from the tree; in many instances the original condition can be restored by artificial means, and in others by the warmth and moisture of the soil; while other classes of seeds can never be restored if allowed once to become dried. There being then so many classes of trees, (growing in all kinds of soil and in all climates,)—no two having seed the same in all their peculiarities—keeping their seeds at nearly all seasons of the year that it would require volumes to give anything like a detailed description of the peculiarities and circumstances necessary to successfully raising all classes of forest trees from the seed.

A few practical hints, upon a few of the leading varieties, is all I will venture here. I shall not confine myself to classes found in northern Wisconsin, but will refer to nearly all varieties adapted to forest culture on the prairies. Deciduous trees (those that shed their foliage in the fall) being more easily propagated from the seeds than evergreens, will be first noticed.

The elm, and silver or soft maple, both being adapted to a moist, rich soil—such as usually make best meadow lands—are usually found growing together. The seeds should be gathered and planted as soon as ripe, which is very early in the season—(in May or June;) they will grow at once, and will make a good growth the first season. If the seed is to transported any distance, it must be packed in such a manner as to keep moist. If allowed to dry it will seldom germinate, especially the maple. To keep them moist they must be packed in boxes with wet sawdust, sand or moss. The sugar maple, oak, ash, white and red pines, white and black walnuts, all mature their seeds much later and will thrive on a greater diversity of soils; they will thrive very fair on a lean, sandy soil, but much better on a rich clayey loam, and, with the exception of the walnut, will not thrive well upon the same soil, and along with the elm and silver maple. We sometimes see a solitary white pine and oak growing here and there (of gigantic size) in a forest of elm and maple. In such cases they are the "monarchs of the forest." White pine and white oak will thrive exceedingly well on a low, damp, (not water soaked) soil, (such as is adapted to a silver maple and elm) if once well started, but there is usually great difficulty in getting them started, as a hard freeze in winter, when water stands on the ground is sure to kill the young plants, but when once sufficiently rooted, too deep for the frosts, they make very rapid hardy growth. This is evidenced by their growing so scattering and to such dimensions, whether growing alone or in connection with other classes of trees, in such locations. But few of the young plants succeeding in withstanding the freezing ordeal. Again the ground must drain out, deep enough, so the roots will not find water "standing" in the soil. Planters had always best select high and dry land for the above trees.

There are varieties, however, that will thrive best in very wet soils. Larch, birch, balsam, fir, arborvitæ, and spruce, for instance, will germinate very quickly, in very wet ground, and will grow very rapidly, especially larch, which will make from four to six or eight feet growth annually on rich swamp lands. There are through the West thousands of acres of swamp lands, now entirely valueless, which if planted to larch and spruce, would soon yield a rich income to the owners. Drying does not injure the seeds of the above varieties if sown on very wet, swampy soil. All can be transplanted, after the seedlings are well started on uplands, and will thrive very well in a rich loam or clay, but seldom do well on sand.

I have now given a general review of the planting of seeds. I will now give some directions more in detail.

PREPARING THE SOIL AND PLANTING THE SEEDS.

If the seed is to be planted where it is intended the forest shall ultimately stand and in tillable land, prepare it thoroughly for corn, (and if you plant the seed in autumn), with a shovel-plow make furrows about four feet apart for the rows, strew the seeds in the bottom of this furrow, cover them slightly with old compost, rotted leaves, straw or moss, leaving the earth to be worked down the sides of the furrow by the freezing and thawing during the winter. If you plant in the spring, prepare the ground as you would for corn or potatoes, as soon as the frost is out of the ground; plant your seed in hills or drills; be sure and plant seed enough,

so you will have plenty to thin out and leave the best trees to grow; cover the seed slightly with soil afterwards, at the proper season plant corn in the spaces between. Nature, almost always, starts her seedlings in the shade; the corn will do the shading, and thus prove of great benefit to the seedlings; besides, in cultivating, the corn and seedlings can be hoed together. In any case, whether in fall or spring planting, the seedlings should be shaded for the first two or three years, either by planting corn, or with a covering of lath erected over the rows to protect them from the sun. The seedlings should also be hoed, (the soil kept loose and free from weeds,) and the plants properly cared for during the first two or three years, to allow them to get a good vigorous start. After the first year the ground should be mulched with rotted sawdust, old compost, or any substance that will keep the sun and dry winds from the soil. (Mulching is of advantage the first year, taking care not to choke or obstruct the growth of the young seedlings.) A continued cultivation for a few years will give the trees sufficient size as to require no further attention; their shade, with the mulching of the leaves they shed, will keep the soil in good condition.

It should be remembered that the seeds of forest trees sprout *very early in the spring;* and in such soils as cannot be worked the moment the frost disappears from the ground, it is necessary to perform the planting in the fall.

This method of planting (where the forest is intended to stand) is not usually practicable with any varieties except those growing naturally on dry land, and having large, coarse seeds—such as walnut, chestnut, oak, hickory, &c. But the maples, birches, elm, larch, and all classes of evergreens, have such small seeds and their seedlings are so minute as to render this method of planting unsafe. I may add, however, that maple and elm may be successfully planted on bottom lands, in this manner, but in all circumstances it is much better to bed them out.

Those trees having *very small* seeds and consequently, very minute seedlings should be first started in a bed. The soils best adapted are, firs, white and Norway pines, hemlocks, red cedar and birch, a dry sandy loam, or clayey loam, and for spruce, arborvitæ, fir and larch, a wet sandy, or loamy soil, the wetter the better if not so wet as to absolutely drown the young seedlings, and for elm and silver maple, a moist clay loam or clay is best. The kind of soil where the tree is found growing in the native forest is not always the best soil for them to grow in; for experiment has shown that some kinds (as fir, spruce, and arborvitæ) are nearly always inhabitants of wet places and swamps, and yet grow more rapid when transplanted to the uplands, but their seeds germinate more readily and the seedlings get a surer start in the wet swampy places, consequently they are seldom met on the uplands. When sowing the seed we should select a location as nearly similar to the one occupied in the native forest as practicable.

The soil should be thoroughly worked and pulverized and made into beds about four feet wide, the same as for sowing onion seed and the seeds sown in drills six or eight inches apart.

They should be covered by sifting fine mould through a riddle, to a depth not exceeding one-fourth of an inch, then throw on two or three

inches of chaff or fine straw or sand. They should be shaded as soon as the minute plants make their appearance, and a portion of the straw removed to give the plants air. This may be done by suspending lath upon poles a foot above the bed. Cotton cloth has been recommended but lath are preferable as they can be easily moved along on the poles while weeding and cultivating; all weeds should be carefully kept away from the young plants, and as soon as their size will admit, a slight mulching should be applied; after being thus carefully cultivated for two or three years, and having attained a size of eight or ten inches, they may be transplanted to their ultimate destination, where they will require but a year or two cultivation and mulching, when they will have attained sufficient size and strength to master intruding weeds faithfully and regularly, and will furnish their own mulching.

I add a few directions and suggestions from S. Edwards, of La-Moille, Ill., the pioneer grower of evergreens in his own great Prairie State, and now the honored president of the "Northern Illinois Horticultural Society." He says:

The ground for seed-beds should be deeply pulverized, and three or four inches of the surface should be mostly composed of sand and wood soil, sand predominating. The small varieties of seeds should be barely covered; the largest ones never over half an inch. Beds four feet in width, running east and west, may be covered with strip lath, nailed one-third of an inch apart to cross pieces, placed a foot above the surface, to protect from direct rays of the sun.

Boards should be placed along the south side of the beds. A slight covering of moss over the beds to maintain moisture is beneficial, but should be removed before the plants prick through it, as they are very tender and easily broken. Remove the covering at dusk each evening, give a slight sprinkling of water, and replace the covering before sunrise.

"Damping off" at the surface of the ground is the greatest difficulty to be encountered in raising evergreens from the seed. Whenever plants are found thus affected, give the beds a liberal sprinkling of dry sand, to be repeated if found necessary; this is an effectual remedy.

Robert Douglas, Esq., of Waukegan, was, it is believed, the first western nurseryman to introduce this mode of culture.

The first winter leaves two inches in depth are laid among the plants for protection. On a small scale, they are readily grown in shallow beds, say six inches deep, nearly filled with the sand and wood soil, placed on the north side of a hedge or other screen. At two years, or if standing thinly in seed-beds, at three years, they should be transplanted to nursery rows running north and south, two and a half feet apart, eight inches in the row. If land is not underdrained, it should be ploughed in lands some thirty feet wide, with deep dead furrows between.

In two years alternate plants, and two years later alternate rows, should be removed. Until planted in their final location, evergreens should be root-pruned or transplanted once in two, or, at most, three years. This induces the putting forth of fibrous feeding roots near the body of the tree.

I also add an extract from J. J. Thomas:

"The seeds of different kinds of trees require very different treatment, the elm, for example, matures its seed early in the season, and it may be planted at once and grow the same season. The maple, pine, oak, chestnut, and nearly all forest trees, do not mature their seed till autumn, and they must be planted either then or early in spring, according to circumstances. Those which have a horny covering, like the chestnut and horse-chestnut, must never be allowed to become dry, because the covering is then impervious to moisture and they will not germinate.

As soon, therefore, as the ripe seed drops from the tree it should be either planted immediately, or "else mixed with some material that will retain moisture, such as moist sand, or peat or damp moss, and kept in this state until planted in spring; or the seeds may be left on the surface of the ground, secure from the attacks of mice and covered with moss or forest leaves. This exposure to the weather will cause them to sprout early, and they should therefore be planted as soon as the frost leaves the ground. The failure of germination in nuts and other seeds is commonly owing to their becoming dry before planting. Frequent alternate soaking in winter and exposure to frost, will often restore them; and they will sometimes grow the second year after planting if the drying process has not extended too far, but the only certain way for success is to preserve a uniform degree of moisture from the moment of the dropping of the seed until vegetation commences." He goes on to say:

Leguminous seeds, the locust for example, do not require the precaution just mentioned, as they become thoroughly dry on the tree. The seeds of the yellow locust, however, (*Robinia pseudo-acacia*,) will never grow if merely planted in the usual way, in their hard and horny state. The best mode among planters is to swell them by scalding in the following manner: Pour boiling water into a tin pan containing about a pint or a quart of the seed, and allow it to stand several hours in a warm room. A part of the seed will then be found to have swollen much in size, and to have assumed a lighter color. They may be separated by the hand, or by means of a sieve that will just allow the unswollen seeds to pass through; and if now planted will come up freely. The remainder may be again repeatedly subjected to the same process until all have been prepared.

Seeds of the pines and spruces are mostly quite small, and the young plants being minute and delicate are liable in this country to be destroyed by the hot sun. The best way, therefore, is to plant them in beds of finely pulverized mould, and keep the surface shaded by screens of white cloth or of straw matting. The cloth succeeds the best, as it allows the free admission of light, but not of the hot rays. After two years' growth these seedlings are transplanted into nursery rows, or where they can have more room. It sometimes happens that the seeds of evergreens, as well as of other trees, when sown spontaneously in the shade of thin woods, will come up and grow thickly without any care being given to them; but this mode cannot be relied on, and may be adopted only to advantage where it is found actually to occur by excluding all cattle and other intruders which would destroy the young plantation, and subsequently, in

a few years, cutting away the larger growth, so as to give the young trees an even chance.

DEPTH FOR PLANTING SEED.

The depth should be nearly in accordance with the size of the seed. The smallest evergreens, for instance, should not be buried more than the fourth of an inch. It is usually performed by sifting fine mould over them to this depth. The larger pine seeds may be placed half an inch to an inch deep. Maples should not be covered deeper than this, while two inches will not be too deep for the chestnut, and even three inches for the larger nuts. This depth, however, must be somewhat modified by the character of the soil. If heavy and compact, they will bear a less depth than in a sandy, porous, or gravelly earth. Seeds planted very early in spring should have a shallower covering than later in the season, when a greater depth may be needed to secure proper moisture. Deep planting is always disadvantageous, as numerous experiments have fully shown, but must be resorted to in dry soils, to prevent the greater evil of not growing at all.

Planting seeds late in autumn is better than spring planting, because no injury can be done to them by removal or handling after sprouting has commenced, and the trees usually receive an earlier start. The only disadvantages are a liability to be destroyed by mice in winter—an evil the probability of which must be judged by every planter—and the formation of a hard crust by the long settling of the soil, through which the young plants cannot readily penetrate. This difficulty is greater on heavy than on light soils, and may be prevented by sprinkling or sifting over the surface before winter sets in a coating of fine manure, pulverized compost, or leaf-mould, or peat.

Another mode of starting the seed, especially in regions formerly timbered, is by sowing the seed broadcast where the trees are to grow. This is usually a very uncertain mode, as the seedlings cannot be subjected to cultivation and are liable to be overgrown with weeds and grass. The most successful method of obtaining a good broadcast growth from the seed (except on the wild open prairie) is, to burn over the whole surface just as the vegetation dies in autumn, before sowing the seed. The burning will pretty effectually destroy the seeds and roots of every thing not wanted, and leave the ground mellow and in prime condition for the little seedlings to take ready root and when large enough to move they are thinned out, and the seedlings transplanted in nursery rows or where additional tree plantations are desired. In some cases where the seeds are sown thus broadcast, the entire growth is moved to form plantations. *This broadcast sowing of seeds should never be attempted on the unbroken prairie.* This method of moving the seedlings is attended with considerable expense, but is really cheaper in the long run than the more hasty and superficial practice, of risking the plants on unprepared and uncultivated ground where but little growth can be made and many plants die of neglect, and leave them uneven and unthrifty plantations of crooked trees. Where trees are transplanted to form plantations, it should be done in rows where they can receive regular cultivation for a few years. The growth which they will make under such treatment, will be many

times greater than under neglect. It is a well known fact, that young peach trees under good cultivation will produce annual shoots three or four feet long, while those uncultivated and bound with grass and weeds scarcely make as many inches growth.

It may be laid down as a general rule that trees on mellow ground and well cultivated will make at least treble growth; or in other words, the young trees under good management will make as much growth in three years as they would in nine or ten if neglected. When the land is valuable, the management which gives the quickest growth and the heaviest return of timber in a given time is the most desirable.

If the soil is in good condition and is kept well cultivated, the trees will not only outstrip those uncultivated, but will make a better and more valuable growth. In thinning out the trees, the sickly crooked ones should always be removed. If after they are well started, those having a feeble crooked form, are cut out in winter or early spring, fresh, young and vigorous shoots will almost invariably spring up in their place. On such surfaces as do not admit of cultivation, it is very important to set them thickly enough at first, to shade the ground, and in a short time the fallen leaves will form a mulching that will keep back weeds, and they will also protect each other against the effect of the winds. Young trees, thus planted thickly, will usually be found to do well, when isolated trees in exposed situations, will grow but feebly or perish.

A TEDIOUS BUSINESS.

Experience in raising forest trees from the seed is so limited and there are so many kinds of trees, possessed of so many peculiarities, growing in so many different latitudes, and upon such a diversity of soils, that there are many chances against success. Were we as sure of success in planting the tree seed as corn, it would be far the cheapest method of obtaining a timber plantation. A few have been successful in growing some kinds of forest trees from the seeds. Others are exclusively engaged in raising evergreens from the seed with fair success, and yet they find much difficulty, even when making it their study and business.

Could one go in person to the forest and gather the seed as it drops from the trees or immediately after falling and carry it but a short distance and plant it at once in *good condition* upon soil similar to that upon which the parent tree grows, success would be almost certain; but there are so many chances aginst seed transported long distances. They may have sometime been allowed to dry, or in keeping them moist they may have been allowed to heat or mildew; in either case they would be nearly worthless.

With all the circumstances combined against it I cannot recommend seed planting in general. A man intending to make raising and selling forest tree seedlings a business would doubtless succeed with most varieties.

CHAPTER IV.

PROPAGATION BY CUTTINGS.

The next method of starting a forest tree plantation is by cuttings; this may be practiced with some degree of success with most classes of

deciduous trees. One can hardly expect to succeed with the cuttings of evergreens.

This method of starting trees will be considered but briefly, not being universally practicable.

To be successful in any branch of tree-culture, it is quite important that one should understand the *rationale* upon which his operations are founded, and in no branch of the business does this apply with so much force as in the propagation by cuttings.

There is, however, in this, as in all other branches of forest tree culture, much that remains unexplained. We know not why it is that some classes start readily from the cuttings while others seemingly of similar structure start with the greatest tardiness and difficulty, or not at all.

We have no knowledge of any thorough or extensive experiments ever having been made in this branch of propagating forest trees; therefore, we are unable to give any lists of classes or varieties that have been found to succeed or fail. But a few general hints is all we can venture, with a view only of aiding those who may wish to try the experiment:

A cutting is defined as a branch of a tree that is cut off and placed in a position to form roots of its own, independent of the parent stock, and thus become an independent individual plant, possessing all the properties and being a living representative of the original from which it was taken.

The proper time or condition of wood-growth, varies much with the different classes of trees. Experiment has not yet fully ascertained this question. As we know of no appearance or condition of the plant that will indicate the special proportionate arrangement of the constituents most favorable for the formation of roots from the cuttings.

As the extension or formation of roots is dependent upon the action of the foliage, that condition or stage of wood-growth, which give the shoots or cuttings a full supply of the organized matter necessary to a ripening of wood growth; in which the process of vegetation is still in full operation, with but little if any tax upon the roots for nourishment, will furnish the best shoots for propagation. In other words, it has been found that as a general rule, that cuttings should be taken from those that have commenced to mature but still possessed of active and healthy foliage, known as "half-ripened wood," in a state rather to develop, than to depend upon the roots.

After proper cuttings in proper condition have been secured, the art of "striking" or starting the roots, consists mainly in preventing the atmosphere from drying out the sap of the shoot until roots are formed sufficiently to supply the evaporation. For this purpose various expedients are resorted to, such as covering the cuttings with boxes with glass tops, which prevent the escape of the moisture, but admits the warmth and light of the sun.

I present an extract from William Sanders, of the Experimental Garden at Washington:

The greatest care is required in the case of young, tender cuttings, and the least with those of matured wood. Cuttings of the latter frequently succeed when planted in the open air without further care or attention. On the other hand, a young succulent cutting, furnished with

one or more leaves, must be carefully guarded against excess of light and aridity. Shading from bright sun will be required to prevent the foliage from wilting, and its surrounding atmosphere must be sufficiently moist to prevent evaporation from its surfaces.

The great stimulents of vegetable life are heat, air, light, and moisture, and in the management of cuttings these agents must be regulated with care and precision.

Under certain conditions, cuttings will grow and produce a few leaves without any attempt at the formation of roots, while under different circumstances the same kind of cuttings will produce roots without indicating the slightest symptoms of bud-growth. Heat is the active stimulant of the vital forces of plants, and when the atmosphere by which they are surrounded is of a comparatively higher temperature than the soil in which they are placed, the branches are excited before the roots receive any impulse. On the contrary, when the soil is warmer than the air, the root-forming process will be active, although the branches show no indication of growth. Of course neither of these conditions can continue exclusively for any lengthened period, for without a reciprocal action all growth will, in time, cease. These effects are frequently illustrated in tree-planting in spring. Towards the latter portion of spring and the early part of summer the air is many degrees warmer than the soil; the heated atmosphere excites the buds, and the leaves are developed; but the recently disturbed roots in the colder soil have not yet been excited, and are not in a state to supply the demands of the foliage, the juices of the tree are soon exhausted, and the promised healthy growth is suddenly and hopelessly checked.

The main point of consideration, therefore, in the management of cuttings, so far as mere application of heat is concerned, is to stimulate into action the processes carried on in the vessels of the cutting inserted in the soil while the upward bud-growth is retarded. This is secured by heating the soil, and not heating the air. The rule is that cuttings should be kept in atmospherical temperature as low as the nature of the plant will allow, and the soil in which they are inserted should be warmed as high as the roots will endure. The more completely these conditions are maintained the greater the certainty of success, and with ordinary care few failures need occur.

Trees can be started from the cuttings with a good degree of success, where one has the trees growing from which to take the cuttings, or even imported cuttings can be made to "strike," but in either case artificial heat in the soil, or "bottom heat" in the soil is quite essential to good success with most varieties. I quote again from Mr. Sanders:

"Bottom heat," as it is termed, or a warming of the soil, may be attained by various means. Those whose requirements are extensive, usually have a structure specially fitted to the purposes of propagation, where the soil is heated by hot water either in pipes, or wooden or cement tanks. The latter mode is, perhaps, the best; but where the quantity desired is limited to the wants of an ordinary flower garden or greenhouse, no special structure need be necessary. A small hot-bed, with frame, will afford considerable convenience; and those who have a greenhouse may form one of the best propagating shelves by enclosing a portion

of the heating channel, whether flue or pipes, at the warmest end, so as to form a tight chamber, with the heater passing through it. Usually there is a front shelf in greenhouses over the heating apparatus, so that by simply enclosing a space below it, an air-chamber will be formed, where the heat will collect and warm a bed of sand or soil laid on the shelf. For all ordinary purposes this will be found sufficient, and the space can be enlarged to suit the wants of the propagator.

CHAPTER V.

TRANSPLANTING FROM FOREST.

By far the most successful and most universally practiced method of starting tree plantations is by transplanting. Millions of trees are annually springing up over the fertile prairies of the west. The inhabitants of the old timber regions are also taking every spring millions of seedlings and planting them upon the same ground where recently grew the mighty forests, hewn down with ruthless hands and consigned to the flames.

The great and increasing needs of forests are making their impressions and millions upon millions of plants move from their native forests every year. A number of individuals are devoting their entire time and attention to starting forest trees from the seed; but they do not supply a tithe of the demand. Indeed, the expense of starting from the seed is so much greater than gathering from the native forests, that the forest trees are preferred even the many chances against their success not found with nursery trees.

Evergreens, being usually more desirable for timber plantations, windbreaks, screens, and yard ornaments, and being more difficult to start from the seeds and cuttings are very largely sought in the native forests.

It is usually conceded that evergreens from the native forests cannot be removed and transplanted without much more danger of loss than with nursery trees, except in the case of seedlings or very small plants.

Several years experience in handling and shipping many millions of evergreen trees, has taught me that evergreens (when properly handled) *can be removed* from their native soil with nearly the same success as from the nursery. A little racy examination of the physiological condition and relations of evergreens and other trees, in connection with the directions for handling and planting, will present the subject a little more understandingly.

It is well known that plants feed upon fluids enriched by the ingredients of the soil, and that their roots possess the mouths that take up the food. These mouths are called spongioles; they consist of lax, spongy, cellular, tissues upon the extremities of the fibres. These spongioles are extremely delicate in their organization, and a very slight degree of violence destroys them. It is scarcely possible to remove the soil from the roots without injury, and if removal or transplantation is effected violently or carelessly they are in a great measure destroyed. As the tree advances in age and growth the food becomes exhausted from the soil im-

mediately about the tree, and the roots stretch themselves and reach out to the adjoining soil, and send out their spongioles or mouths for more food. Hence the greater difficulty of removing large trees; these spongioles are upon the extremities of these long roots and are more liable to destruction by removal. With a view to preserving these spongioles, came the notion of removing, with the tree, a large, clumsy ball of earth. This is objectionable, for this reason: the soil in immediate contact with the roots has become nearly or quite exhausted, and will prove a damage if planted with the tree, as is practiced. The only good of the ball of soil is to keep these spongioles moist and uninjured; any other device accomplishing this end would be preferable. By thoroughly shaking the old soil from the roots and taking care to preserve these spongioles moist and uninjured until the tree is planted in new, fresh, well prepared soil, success is more likely to attend the removal, as then the spongioles would be brought in immediate contact with good fresh soil, well stocked with good nutricious food. In many cases where these spongioles have been, dried and injured, they are speedily replaced, particularly in deciduous trees, provided a slight degree of growth be maintained, as in the case of cuttings. This is a reason why trees should be transplanted after the buds begin to swell.

Many of the causes of success or failure in transplanting trees, is often very little understood. Much has been said and written upon this subject; the whole range of vegetable physiology has been called in aid of an explanation of the theory; with all, it can be proved to depend entirely upon the preservation of the spongioles of the roots, and the prevention of excessive evaporation—the effort for life then in the tree is the most vigorous and the first impulse of nature is to supply new mouths with which to feed during the season for growing; this impulse is excited by the moisture absorbed by the roots.

In the spring, these mouths or spongioles, are all open and grasping for moisture and nourishment; the foliage is struggling to burst from the confinement of the winter; the sap, which has been for months dormant, is struggling to begin again to course its way through the forest; any condition of the roots that prevents their absorbing moisture, after the death of the spongioles, is death to the tree. These spongioles are in reality the lower terminus of the pores in the "sap" of the tree, and it is through them only that nourishment is taken from the soil, hence the moisture absorbed by the roots, after the death of the spongioles does not nourish the tree itself, but only excites an effort on the part of the roots to reopen, the lower terminis of the pores, and thus form new mouths, or spongioles, forthe taking of food. This taking of food is only put in operation during the summer or growing season, hence, all other circumstances being equal, the fall is the best time to remove trees, as then they have more time for the roots to absorb moisture and excite the reopening of the pores, (i. e.,) forming new spongioles, before the growing season commences.

The difficulty in transplantation is augmented very much in proportion to the size of the tree; the larger trees send their roots farther and the spongioles are much wider spread, and much more liable to destruction. If by any means the spongioles could be preserved unharmed, there

would be no reason why large forest trees could not be removed as safely as the smallest nursery trees; but their preservation is rendered impracticable in proportion to the increasing size of the tree.

Plants reared in pots are transplanted so much more successfully than if taken from the soil, because of the security of the spongioles from injury when the earth is undisturbed. This difficulty of moving large trees may be in a measure obviated by cutting with a spade the larger roots the year previous to removal. In a healthy plant new clusters of fibres with new spongioles are emitted wherever the roots are cut through, and the plant is much more easily taken out of the ground, with the spongioles uninjured than if the roots terminating with spongioles were longer and much more scattered through the soil. In such cases, however, the soil about the tree should be kept supplied with an abundance of nutriment. The occasion of trees sending out these long roots is to seek new supplies of food, the nourishment in the soil being nearly or quite exhausted about the trunk; and preserving the roots but interferes with the growth of the tree rather than inducing it to send out new fibres.

This action of the spongioles is kept up by perspiration or evaporation from the leaves. The evaporation tending to produce a vacuum, draws the sap from below; hence trees should never be removed during the growing season, as during their transit their condition must necessarily be very unfavorable for the spongioles to supply the loss by evaporation—and the more rapid the evaporation the greater the danger. Evergreens can be removed with much less danger during the growing season than deciduous trees—their evaporation being so much less copious, that with proper care they can be transplanted in almost all months. Yet, even evergreens cannot be safely removed in the hottest months in the year, because then the action of such spongioles as may be saved in the operation would not be sufficient to supply the waste by evaporation.

Evaporation takes place in plants to an inconceivable degree under certain circumstances. It is known, by the experiments of Dr. Hales, that a sun-flower plant will lose as much as 1 pound 14 ounces by perspiration in twelve hours; and that in general, "in equal surfaces and equal times, a man would perspire one-fiftieth, the plant one hundred and sixty-fifth, or as 50 is to 15;" and that taking all things into account, a sun-flower perspires seventeen times more than a man. The same most accurate observer found that a cabbage perspired in twelve hours 1 pound 9 ounces; a Paradise stock in a pot, 11 ounces; and a lemon plant 8 ounces. Guettard states that he found a Cornus mascula perspire twice its own weight in a day; and Mr. Knight has remarked a vine in a hot day losing moisture with such rapidity that a glass placed under one of its leaves was speedily covered with dew, and in half an hour the perspiration was running off the glass. In damp or wet weather, this evaporation is least; in hot, dry weather, it is greatest. This loss has all to be supplied by the moisture introduced into the system by the spongioles; and hence, if the spongioles are destroyed, and evaporation takes place before they can be replaced, a plant must necessarily die. This is the reason why deciduous trees cannot be transplanted when in leaf; it is difficult to remove them without injuring their spongioles, and it is equally difficult to hinder

the evaporation by their leaves; but if they are kept in pots, it matters not at what season their removal takes place, because, as their spongioles are then uninjured, even excessive evaporation would be made good by their action.—*John Lindly, M. D.*

I will notice one other peculiarity of evergreens and larches. Nature has supplied their sap with a large proportion of resinous matter, which, on a little inactivity and drying coagulates or thickens and becomes resin, which fills and clogs the pores of the tree, so that nourishment cannot ascend, and this gum or resin is not soluable in water, and can never be induced to resume its original consistency.

The distinctive peculiarity of nursery trees is the position of these spongioles. In nurseries properly conducted, a system of root pruning is practiced and the soil in the immediate vicinity is by proper manures and culture constantly kept charged with food for the growing tree and a thorough system of root-pruning is pursued, and the spongioles are thrown out in great abundance immediately about the stem, and consequently a less number are destroyed in digging; yet, with improper handling allowing these spongioles to dry, there is, particularly in the case of evergreens, as much danger of nursery as of native trees.

From the foregoing it is easily understood what is the proper method of digging, handling, packing and planting native evergreens. The following rules are but corrolaries to the foregoing:

1st. In digging lift all the roots possible, however wide spreading and long they may be.

2d. Never allow the moisture to dry off the roots. If dug in a drying day, they should not be allowed even five minutes exposure to the air, but should be immediately covered with wet straw, moss or leaves, and thus protected until packed or healed in, in moist soil.

3d. They should be packed in such a way that the roots will remain thus moist and preserved from drying and at the same time supplied with food for their use during transit. To secure this the most effectually, the roots should be thoroughly immersed in a puddle of clay or adhesive soil, and packed in wet moss, which will supply the requisite moisture, and the air as effectually excluded from the roots as while growing, and the tops allowed sufficient air to carry off the exhalations of the leaves, and thus prevent heat and mould. The boxes should be as much as possible exposed to the air, (but not to the sun), they should not be packed closely in the holds of vessels or steamboats, as then their noxious exhalations cannot escape.

The following remarks clearly elucidate the three foregoing rules:

1st. As many as possible of the long roots should be secured to secure as large a number as possible of the spongioles which are mainly upon the extremities of these long roots.

2d. The moisture should be preserved in order to preserve the spongioles uninjured, and more particularly in the case of evergreens, as the drying so coagulates and converts the sap into resin, as to effectually clog the pores, in the roots especially, where the sap is much more resinous than in the branches, and completely check the flow of sap upwards. This rule is much more important than the first, as if the spongioles are nearly all destroyed and the roots kept moist and healthy, they will at

once open out new spongioles, and succeed in withstanding the shock of removal, if the season is favorable and they are properly planted in good soil, and properly shaded so as to avoid the too great tax upon the spongioles for furnishing moisture.

3d. An evergreen is constantly at work when not frozen; its leaves commence their exhalations as soon as the frost is out of them, and it requires a constant supply of food. The supply required when not actually forming new wood is quite small, and may be, in very favorable circumstances, entirely dispensed with for a few days, but never safely. The puddling furnishes the medium through which the spongioles can act, and the moss furnishes the food and preserves the moisture. When the trees are packed in straw, the puddle should be a good rich adhesive soil, as the straw furnishes but little if any nourishment. The less the leaves perspire, the less food there is required. There are therefore two reasons why the trees should not be exposed to the hot sun either just before or at any time after packing. 1st, Because of the danger of drying, and, 2d, Because of the rapid perspiration thus produced. The light of the sun is the great force that causes the *respiration* in plants, and the *perspiration* is the consequences of the *respiration*. By respiration plants inhale carbon from the atmosphere and the perspiration produced, is the giving out or exhaling oxygen. Plants shut up, air tight, but exposed to the sun, as in an air tight glass jar, soon convert all the surrounding atmosphere into nearly or quite pure oxygen. Heat is produced by combustion, which is a union of oxygen and carbon; the tendency to this union is quite strong, in the case of pure oxygen. A beautiful illustration of this may be made, by placing in an air tight glass jar a growing plant, and after a few hours introduce a candle with the blaze blown out but a spark left in the wick, when it will instantly ignite and burn with great brilliancy. Now, trees packed in air tight boxes, or stowed closely in air tight vessel holds, very soon, convert a large portion of the surrounding atmosphere into oxygen, and there is an abundance of carbon in the plants themselves with which the oxygen can support a slow combustion which develops heat, and as the heat is developed, the combustion is augmented even in some cases to the point of actual ignition. I have known a box of pine when taken from the hot sun and packed closely in large bulk, to heat in a few hours so that a thermometer introduced through a crevice in the box showed 155 degrees.

As the roots do not perspire, (give out oxygen) and their natural condition is not in the air—therefore, they should be as effectually excluded from the air as when standing. These very particular conditions required by the tops and roots of trees when packed for transportation long distances, has been with me a subject of much thought and many experiments.

The planter can easily determine whether his evergreens have been injured by drying, by simply taking a knife and cutting the roots a little. If they appear dark or gummy under the bark, better throw them away at once than to be to any more expense with them, as they have undergone the drying process, which is death to them.

We have now followed the evergreen from its native soil to the planter,—noticing its condition and demands in all the different condi-

tions through which it passes,—now, a few words to the planter and we leave the subject:

First, When is the best time to get trees and transplant them. The relative advantages of spring and fall planting have given rise to many opinions, and it is not strange that a wide difference in opinion should be held on the question.

It is in many particulars theoretically true that autumn is the best time for removing trees, especially evergreens. During the month of October, the soil averages ten degrees warmer than the atmosphere; this forms a kind of natural hot-bed, which encourages the formation of new fibres and spongioles, in place of those destroyed by removal, and the low atmospheric temperature prevents any growth in the branches, which is exhausting to the roots. Thus they have more time for resuscitation, and preparing for an unobstructed growth. We cannot, however, believe that practically, fall is the best time for planting, as in clayey and heavy soils the spongioles may be destroyed through constant saturation and soaking, by the water gathering in the hole where the tree is planted; or the roots may not get sufficient hold of the soil, that the alternate freezing and thawing will not constantly be tearing off and injuring the fibres and spongioles. And again on the very bleak and exposed prairies the drying westerly winds of early spring, will exhaust the juices of the branches and leaves by evaporation when the roots are not in condition, to supply the loss. We would say then generally, *especially on the prairies*, plant your trees in spring.

It would, however, be advisable to procure your trees in the fall, but be very sure that they are shipped early enough not to be frozen on the route as freezing and thawing suddenly is very liable to twist off and destroy the young rootless and spongioles; but if they should be received in a frozen condition, place them in a cellar or some other situation in which the thawing will be very gradual and not exposed to the air.

Very early spring planting is subject to the same difficulty, (i. e., of drying prairie winds) as fall planting. But in case of fall or very early spring removal, the trees should be buried, root and branch, with the roots furnished with a sufficient supply of nourishment, and there kept until the proper time for planting which should be about the time the young shoots of growing trees exhibit signs of pushing, never earlier, anytime thereafter will do, if other circumstances are favorable. A moist, rainy time should be selected for planting. If the trees have been puddled in clay when packed, the clay should be rinsed off in water made thick with good rich soil, which may be done by taking the bundles or single trees, by the trunks and "sousing" them several times up and down in prepared water; this relieves the spongioles from the fetters of the clay and leaves them free to take the food from the soil, plant immediately after rinsing as above. If the trees have been puddled in soil in the first place, all that will be necessary will be to gently brush out the roots and fibres to their natural position before planting, being sure that they are all free to come in contact with the new fresh soil. If the weather is dry the soil should be wet before planting, taking great care to have plenty of rich fine moist soil worked in among the roots, so as to have every fibre and spongiole supplied with food, plant a little deeper than the tree stood in its native

soil, and be sure, for the first season, not to let the soil become dry about the tree; mulching is better than watering.

Having considered the condition and handling of the trees from the forest or nursery to their destination, I will briefly call attention to their handling while in the hands of the planter. Their proper handling here is not second to that previously demanded. As soon as received, especially when shipped long distances, the boxes should be opened, (but not until a trench has been properly prepared,) and the crooks and contortions as far as practicable, straightened out of the roots and branches, as fast as the trees are taken out and placed in the trenches, where the roots should be thoroughly covered with good fine earth; and if the trenches are in a position exposed to the hot sun, the whole should be covered with straw, boughs, boards or anything to prevent the too rapid evaporation of their juices. As far as practicable they should be kept in this position until a rainy time before planting; unless the buds are pushing too rapidly, when they should be planted immediately, and the shading mentioned hereafter should be placed close upon the trees, if not too large. Great care should be taken not to allow the moisture to dry off the roots, at any time. Nurserymen and others almost universally recommend the cutting smoothly of all mutilated and broken roots. I very much doubt the propriety of this, especially if the tree is planted in good, rich, new soil, and more particularly with evergreens than deciduous trees. Cutting the wounded roots only opens afresh the pores to bleeding or the escaping of the moisture in the roots. The roots broken and mutilated in digging usually have the wounds well covered with the native soil and puddling, and if the trees are so handled and packed as to preserve the vitality intact, the wounds have got a good start toward healing, and the formation of new fibres about the wound has already commenced. Then I would say plant the broken roots just as you find them, taking care not to disturb the soil and puddling adhering to the broken parts, any more than absolutely necessary. If not planted in a rainy, moist time, the soil in which they are planted should be thoroughly wet, not so as to be muddy or water soaked, but so as to furnish at once nourishment to the roots, and the drying of the soil should be obviated by a mulching of half rotted chaff or straw. The trees should be set a little deeper than they stood in their native soil, and the larger ones, particularly on the prairies, slightly inclined to windward.

TIME FOR PLANTING.

The proper time for removal and transplanting has been a subject of much discussion. It seems to be universally claimed that the earlier in the spring a tree is planted the better, without reference to the locality from which the tree is taken. Now, there can be no greater mistake than this. The time of transplanting, with reference to the season, should be governed *altogether* by the season of the locality where the tree is wintered.

We have before seen that the great immediate requisition of the tree when transplanted is new fibres, with their spongioles, to receive food, and that an immediate supply of moisture may ascend to supply the waste by evaporation. We should aim to plant in that season which is most favorable to these requirements. This time, with reference *to the*

plant itself, is just as the buds begin to push; then the plant is in the most vigorous condition; its powers are all struggling for new life; its pores are expanding, and its juices are becoming thinned and flow more readily, and the drying winds have a less free access to the juices of the plant—the new foliage not yet having put out, and the old all gone, or in the case of evergreens has ceased to draw sap from the stem. At this time the tree is ready to commence its growth at once. No tree can be safely handled and transplanted after the new growth is fairly under way; the evaporation will invariably destroy the new tender growth, and the old buds having all pushed, and no new ones having formed, the chances for starting again are very limited. The season of the locality where planted is another *very important* consideration.

The universal direction is "Let spring planting be done *early*" without any other conditions whatever.

We have seen that plants draw their nourishment through the spongioles, and that warmth and moisture in the soil are necessary to this. The warmer the soil, the more readily will the fibres reach out and the more rapidly will the spongioles take up nourishment.

It is also well known that the air in early spring is much dryer than after vegetation has well started, and also that the air is much warmer than the soil in early spring. By these it is seen that "early spring" is NOT always the best time to transplant. A little later in the season, the soil has become nearly as warm as the atmosphere, and is in the best condition to nourish the plant, while the atmosphere, being more humid, will not so rapidly absorb the moisture of the plant. Really then, we should be governed in spring planting, by the condition of the plant, as far as practicable. We, here at the north, are constantly pressed with loud calls for trees "earlier in the spring;" one says his trees are needed for Missouri, Southern Illinois, or Kansas, and the season there is very early and the trees are wanted very early. Several years experience in shipping trees from a northern latitude, has shown to me two facts. 1st. The later trees are shipped from here provided they are sent before the buds begin to push, 2d, the farther south the trees go, the more sure the success attending them. I think with these facts and principles, in connection with a thorough understanding of the principles of vegetation, will show to any one that it is much better to come north for trees and to avoid any great hurry for them early in the season. There are, however, reasons for shipping early in spring; the atmosphere at that time is cooler and less humid and the danger of the trees heating in the packages is materially lessened; but this difficulty is avoided by proper skill in packing.

During the month of June, 1867, I packed and shipped half a million of trees two feet high and less, nearly all going to Illinois,—many to the southern part of the State; toward the last many of them were pushed several inches. Remarkable good success attended every lot, in some cases not over one per cent. was lost. While with those shipped in April and May of the same year, with precisely the same packing and the same quality of trees in every respect, very many were lost, and in some cases a total failure attended them. This was owing, in part, to the very drying winds of the early spring, in some cases absorbing all the moisture

from the trees during their transit. That season's business proved an incentive for me to study and devise some method of packing which would avoid the *drying trouble* and still not be liable to suffocation, heat or mould, by too close packing—combining the advantages referred to in the foregoing part of this.

The method finally resorted to has stood the test in every instance.

The method of packing is simply to thoroughly puddle the roots, and press them tightly into small frames, the frames clasping the packages of trees, about the stems between the roots and tops; filling with moss so thoroughly and pressing so tightly, that the air cannot pass from the top to the roots; making the box as nearly as practicable air tight about the roots, keeping plenty of moss between the box and roots, leaving the box about the top all open, with just slats or frame work enough about them to give the box the requisite strength, and to protect the trees from injury. Packed in this way I have shipped trees many hundred miles, and in some cases they have suffered three or four weeks delay, and yet arrive in good condition.

Shading is very important with young evergreens and more especially with forest evergreens. In the case of evergreens with all their foliage the evaporating surface is so great, that the exhaustion of the sap is too great for the immediate action of the roots, when exposed to the direct rays of the sun.

The tax upon the roots, with so large an evaporating surface, is too great for the plant to endure before its roots have got a firm hold of the soil. In this respect deciduous trees have a decided advantage over evergreens. The amount of nourishment demanded is small at first but increases as the foliage increases, giving the roots an opportunity to increase their ability to supply the nourishment demanded.

This shading may be done with both as mentioned in chapter third for shading the bed in starting the seeds, only the shading should be a little more close, and brought down a little closer to the plants, than in raising from the seed. The shading is quite difficult in the case of large trees, four feet and over. I have recommended planters to bind straw upon the tree, inclosing the whole foliage, when first received, and removing a little at a time during the summer. Very good results have been realized by this. Much the best way, however, is to box the tree about with a tight board box open at the top. Either of the above methods is too expensive for large plantations as for screens and timber belts, and is practicable only in the planting of a few trees for yard ornament.

SIZE OF TREES TO PLANT.

The necessity for shading as above pleads the necessity for planting small trees, especially evergreens. But by all means *plant small trees* whatever be the kind of tree you are planting; never order an evergreen from a distance, of more than three feet in height. Large deciduous trees, such as larch, &c., may be handled much more safely. I would not recommend the planting of large trees in any case or any variety, the opinion of many nurserymen to the contrary notwithstanding.

The opinions of F. K. Phœnix being so strikingly in point here, that I reproduce them from his descriptive catalogue:

PLANT YOUNG TREES.

Ordinary-sized apple trees, (with other fruit trees,) of 3 and 4 years' growth are scarce. During the war many nursery stocks declined. Shall we plant younger trees *now*, or wait one or more years, faring then, perhaps, no better, there being a very small supply even of yearlings for the vast demand?

We advise most decidedly to plant young trees, in orchard and gardens, and for the following reasons:

1.—Young trees cost less throughout—at the nursery, in frieght charges, and also in handling and planting.

2.—They are surer to grow, having in proportion to the size of tops, vastly more and better small, fine (fibrous) roots. Large trees in moving usually lose half or more of their most valuable roots.

3—Having less tops and almost perfect roots, the small trees become established, and grow off vigorously at once. The tops of large trees newly planted are often shaken and blown about by the wind until they become leaning, and unhealthy even if they survive.

4.—Making most of their growth on the ground where they are to stand, the small trees soon become more stocky and sturdy, every way perfectly adapted to the soil and location, as well as the preferences of their owner. Setting young trees the planter can fashion both bodies and tops exactly to suit his fancy.

5.—"Setting such young trees will we not lose time?" you ask. To answer truly, I reply, if you give these young trees the first year or two a little *extra watching and care*, to the amount, say, of the difference in their cost, you *will not lose a day*, but get thereby a much handsomer and more valuable orchard.

6.—Or if not ready to plant out in the orchard permanently this year—or, if about to open in a year or two a new farm as for son or daughter, why not plant yearlings or root grafts, growing them yourself in the garden with but trifling cost. In the meantime your children can study and learn all about them as well as about colts or pigs. Root grafts, are set in deep, mellow soil, with dirt firm about roots, dipped, just before setting, in "grout," i. e. mud and water, with the top of Graft or Cion, two inches or so above surface.

The most thorough and successful large planters we cannot persuade to buy and plant ordinary or large-sized trees. Even at the same price they invariably prefer the 1 or 2 year trees, knowing that with a fair chance, the young, thrifty trees will, in four or five years at most, overtake the best planted large trees. It is indeed surprising to witness the thrift and vigor of 1 and 2 year trees well planted and cared for, especially the first two years after setting. Their cultivation is as simple as corn and cabbage. Unless on a side hill where soil washes badly, plant only an inch or two deeper than they grow in nursery, as deep planting ruins many trees. The first season in the orchard two or three short stakes by each tree may be well enough, and then see that the ground is properly stirred, the cattle, vermin and weeds kept away. Planting a few large trees for immediate bearing and effect, as about cities and towns, is a very different matter. In such cases expense and risk are no object. For complete homes, surrounding trees as near per-

fect maturity as possible, are imperatively demanded; hence large sized trees are of prime importance.

The distant dweller on the prairies has neither money nor time to tamper with such large trees. Give him the young trees, and with reasonable care he can soon show better specimens than his more ambitious, suburban neighbor, besides the money he saves by planting small sizes.

FORMS AND PLACES OF PLANTING.

As the great and principle object in planting forest trees is, as it should be, to grow trees for timber and fuel, and in such forms as to afford protection to the land, that is for screens and windbreaks. Upon this point I quote mainly from J. A. Lapham's Report to the Wisconsin Legislature:

FORMS OF PLANTING.

Trees in forests and belts designed for timber or protection against winds may be variously planted, as they may be designed for different purposes, reference also being had to the kind of trees used. Such trees as are designed primarily for their fruit, and ultimately for timber, such as chestnuts, butternuts, walnuts and hickories, might be planted in squares one rod apart, or 160 to the acre, or at 8 feet 3 inches apart each way, thus giving four trees to the rod square, or 640 trees to the acre of land. This would be a good distance for maples designed for making sugar; and for the coniferæ intended to be grown into large trees for timber. This form might be secondarily attained from a thicker plantation thinned out. Apple trees might be used to make this kind of plantation, which being a very fast grower and trimmed high, and after bearing fruit for several years, enough to pay a large rent on the land, would become tall trees with large trunks of valuable timber, and tops making fuel of an excellent quality.

If the plantation of trees be intended for a tree-belt or forest, such a plan must be adopted as will give sufficient space between the rows and trees to allow the horse-hoe or cultivator to pass; then in the vacant spaces some low growing crop, like bush beans, dwarf peas, onions, turnips, beets, carrots and parsnips, might be planted; remembering all the time that these last are but the temporary crop and only planted, not for themselves, but to assist in part paying for the cultivation of the greater crop of trees, during the first years of their existence. Tap roots should never be grown, after the roots of the trees have so extended themselves as to be endangered in taking up the crop of roots. After that period only such crops as produce no roots to be dug should be grown. Such crops, without damaging the young trees, would be a real benefit; as they would induce manuring the ground, and secure thorough cultivation of the surface.

For fuel, and small straight timber, the trees might be grown, either primarily or secondarily, in rows 49½ inches apart, and 8 feet three inches in the rows, standing quincuncially. This form places eight trees to the rod, while they are almost six feet from each other, and gives 1,280 to the acre. Another form of planting for the same purpose would place them in the square form, 5½ feet apart, and would give nine trees to the

rod, or 1,440 to the acre. This last form would be more difficult to attain as a secondary result, but would be a very good form to use, where other crops are grown in the early stages of its growth.

All these forms may be ultimately reached, except the last, by planting seeds at 49½ inches between the rows, and at half or one-fourth that distance in the row; with the express intention of thinning them out at the proper age, so as to leave the final form required. Different varieties of trees may also be used which are intended to be cut away, as the planter shall deem most profitable for that purpose. For this last purpose no species offer more advantages, than hickories and white oaks among deciduous trees, and larches among coniferæ.

Different forms of plantations will suggest themselves to each planter according to the use for which he is planting. But however the trees may be planted, they should be induced to shade the ground as soon as possible, so as to kill out all other vegetation. In this last, the leaves will greatly aid while it mulches and enriches the trees, and aids their growth.

When the land is valuable, as is generally the case in Wisconsin, it is obvious that the management, which gives the quickest and the heaviest return of timber, will prove the most remunerative and profitable. Thorough cultivation gives the greatest and most rapid growth of the young trees, making at least once and a half, and often two-fold difference in the first ten years of their existence. This is accomplished best by planting the trees in rows, through which the cultivator can be passed, thus keeping it clean. This cannot be done by the uncertain mode of sowing the seeds broadcast, or setting the trees at random, moreover it gives greater evenness to the plantation.

WHAT KINDS OF TREES TO PLANT IN TIMBER BELTS.

On this I also quote largely from Mr. Lapham:

Plant the best Trees. In growing forest trees something besides square feet of timber is to be considered. One kind of timber is often worth many times as much as another; thus, a hundred feet of black walnut or cherry planks, are worth from six to ten dollars, while the same amount of pine may be had from two to four dollars; and poplars would not pay for cutting; and the fork of a walnut, white oak, or curled maple, for veneering, would be worth a dollar for a square foot. The butt of a thrifty growing hickory or white ash, eight feet long and one foot in diameter, may bring from one to two dollars, while a similar stick of Lombardy or other poplar would not be worth over fifteen cents. As mere fuel the hickory and ash are worth nearly three times as much as the poplar. Yet the valuable tree will occupy no more ground to produce it than the almost worthless one, and still give the required size in about the same time. This consideration of value should always be kept in mind in planting trees. A tree should not be chosen for planting, simply because it is a very rapid grower, nor yet be rejected because it is of moderate growth. The true questions to ask and answer is this, which tree will be most valuable at the end of twenty or more years.

The planter should remember he is planting a tree for its value at the end of 25, 50, 100, or even 200 years hence, not for what it may be in

five or ten years. The man who plants the seed may see the tree when it is 50 or 60 years old, and may feed on its fruit at ten years. Let him, therefore, plant trees for their value, not merely for their rapid growth. Acting on this principle, there would be no hesitancy in choosing between a balm-of-gilead and a red cedar, or a river cottonwood and a swamp white oak. The valuable tree would be selected, and the almost worthless one rejected.

Timber is required for various purposes. Men want pine, tulip-tree, butternut and basswood to work easy under the plane—white ash, hickory and oak for strength and elasticity—hickory, oak, and sugar maple for hardness and stiffness—young hickory, white oak, white elm and black ash for suppleness—black walnut, cherry, butternut, oak, white ash, chestnut, maple and birch for cabinet work—beech for hard compact wood which will wear smooth, for plane stocks and other tools—pine, spruce, larch and oak, for long straight timber, for buildings and ships—hickory, black ash, and white oak for hoop-poles—tamarack, larch, cypress and pine for hop-poles, stakes and trellises—cedar, locusts, oak and black ash for durable posts for fences, and other purposes—willow, black ash and oak, for baskets. They want all for shade, for forest and for fuel. But least of all they want the whole family of poplars, notwithstanding they are rapid growers.

CHAPTER VI.

SPECIAL CHARACTERISTICS AND VALUE OF SOME LEADING VARIETIES OF FOREST TREES, WITH THE TIME OF RIPENING OF SEED AND PROPER TIME FOR PLANTING SEED, SOIL BEST ADAPTED TO GROWTH, &C., OF EACH KIND.

This chapter is composed mainly of extracts from Mr. Lapham. There are some kinds of trees exceedingly valuable for ornament and shade, which are comparatively valueless for fuel or timber. Who would ever think of planting silver fir, white elm, balm gilead, or Lombardy poplar for any other purpose than ornament? Who would ever think of splitting the white elm, with its fibres braided in all directions, or of using the twisting, curling, springing texture for lumber? But still, the elm has its place. For street planting, through village and country, nothing equals the white or weeping elm. It is easily transplanted, grows fast, towering high its head, reaching in rich lands 80 or 90 feet, is long lived and increases in beauty as it increases in years. Its majestic trunk, braced below, with its bracket shaped root buttresses divides into branches above which support a leafy dome, bending off in finely diverging, gracefully decreasing branches, until they nearly sweep the ground, with their pendant foliage.

Probably no tree (the oak excepted) has been more extolled than the elm, and no tree better deserves the praise bestowed. Noble, graceful, ornamental, fast growing and useful, why should it not receive the praise, the homage of the nations who, like Wisconsin, possess it? In Europe and the United States, great cities, towns, streets, noblemen's and gentlemen's country seats, have received names derived from this tree. It is the boasted ornamentation of New Haven, not less widely known than Yale College. A row of tall elms, a few years ago saved the city of Albany from conflagration. We praise the tree, but give it little

patronage or protection, cutting down a hundred where we plant one, destroying what ought to be cultivated, not alone for ornament, but for its valuable wood, and fine shade and protection.

All lands which will produce corn and wheat, or good grass, will grow some variety of the elm. Trenching upon the borders of the marsh, where contending with the black ash, tamarack and alder, overtowering the sugar maple, spreading its long limbs over the oaks on the dry ridges, or hiding them beneath the pines; it rivals all the trees in the forest in the breath of its range. In all these places no trees mount so rapidly, or make so much wood in a given period of time. Its wood contends with the oak for strength, and the hickory for suppleness, entering into and absolutely necessary for the manufacture of many implements of industry; and as fuel when dried and housed, as all fuel ought to be, it takes a high rank, between the hickory and maple.

ROCK ELM.

This species differs but little from the preceding white elm. The branches are mostly corky ridged, or winged, which render them less slender and drooping. The tree grows as rapidly as the white elm, and the wood is tougher and closer grained. This valuable tree is not very common, and flourishes in drier land than the white elm.

In many places the rock elm is the most valuable timber, ranking next to the oak in value for ship building. Mr. Bates says of it:

Rock elm is tough and very flexible; it has been used in nearly every part of vessels' hulls, but is not very durable above water. It may be used in the bottoms of vessels, and will there prove as durable as oak, though the wood is too easily bruised and split to be well adapted for keels. The best quality of timber is of northern production, and in many parts of the country it is plentiful. It is used in the navy-yards for gun-carriages, and on the lakes for planking and ceiling steamboats and vessels.

Rock elm seems to be but very little understood; indeed, many nurserymen seem to know nothing of it.

F. K. Phœnix, the great western nurseryman at Bloomington, Ill., writes me: I have been in a brown study about that rock elm—and have written several—I know well an elm in the woods which we called, as I remember, 'red elm,' that was not white or slippery, but have lost track of it west. If rock elm were planted extensively, it would prove one of the most beautiful and valuable trees for forest tree culture. It rises in its native forests 40 to 80 feet without a branch, or scarcely any taper, as straight as an arrow, its bark, corky in structure, deeply fluted, and almost white, with bracket-like root buttresses climbing well up the the trunk; its top spreading out not unlike the white elm, but with more erect, coarser branches. Its value for timber seems to be but little known—but where known, it takes the preference over everything else for plow handles, bent work for cutters and buggies, cheese boxes, chair rundles and backs, ox-bows, &c., and is second only to hickory for axe-handles, wagon axel-trees, &c., where stout smart timber is wanted, and when dry, is regarded as fully equal to pignut hickory for fuel, into which it is very easily worked, being very straight rifted and easy to split. Rock elm also grows well upon almost any soil. Its native place seems to be high and dry

land; growing in some places upon rocks nearly bare of soil, whence its name. Its roots, like those of butternut, run so near the surface, that it cannot thrive where it stands too thickly or is crowded with other trees; the young trees and seedlings will soon die out of a thicket of underbrush; yet it is very hardy as against all the changes of temperature, and drouths; hence it is more frequently met where the climate is too severe or dry for other trees to flourish.

The seeds of elm, as before noticed, ripen about the middle of June, and are immediately scattered by the wind. They can be gathered only from the tree, and should be gathered about the time the leaves are fairly put forth on the tree, and sown at once, as if they become dry they loose their vitality.

SUGAR MAPLE.

When usefulness and ornament are combined, whether for streets, yards, groves or timber belts, all other deciduous trees must yield the palm to the old-fashioned sugar maple. It has almost every excellence to recommend it. It bears removal well; when young the roots are two or three times the weight of the top. It only requires good mellow earth for its roots to ramble in, grows fast enough for Young America, is free from insects, dons its dense foliage early in the spring and retains its symmetrical egg shape till the frosts of autumn changes it to the many shades of red and golden, giving it the most brilliant appearance immaginable.

"The seeds of sugar maple are broad-winged and ripen in autumn, falling from the trees with the leaves, and should be planted soon after in rich mould, an inch deep; or kept in a cool, dry place, where vitality would not be excited until early spring. The seedlings will come up about the time the farent tree puts forth its leaves."

Mr. Lapham says: "This tree which is well known in all the states north of the 40th parallel, possesses many valuable properties, one of which is its sweet sap, which flows from the tree while the frost is leaving the ground, before vegetation begins," and from which large quantities of sugar are yearly manufactured. The yield may be estimated from eight to twenty-five pounds annually. The timber is extensively used in cabinet-work, mill-gearing, and naval architecture. When the grains are waivy or undulating, it is called curled maple, and when contorted, bird's eye maple, according to the form of the undulations. Both these when polished are of exquisite appearance, and when kept dry are not less durable than the oak.

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The value of an acre of sugar maple of twenty-five years plantation may be thus estimated. One hundred and sixty trees one foot in diameter, will yield ten pounds of sugar each, or 1,600 pounds, at 15 cents, $250, or deducting three-fourths for labor and expenses, leaves $62.50. This will be its minimum annual yield for fifty years or more.

The timber would advantageously increase in quantity until the trees were 100 years old; but would give a profitable yield of timber when the trees would average twenty inches, as at that size they would give a cord of wood to each tree or 160 cords; and which could not be estimated in the tree at much less than $5 per cord; giving the value of the acre of timber at $800. This estimate will not appear high, when it is remem-

bered, that twenty-five feet in length of each tree can be sawed into lumber, making 300 feet to each tree, or 48,000 feet of sawed lumber, worth at present prices $30 per thousand, or $1,440; and the balance of the trees go to the cord wood, giving eighty cords to the acre. The interest on the value of the land, the cost of planting and taxes would be paid by the trimmings, leaving the land as valuable as when the trees were planted, and the sugar and timber may be estimated as profit for care and forethought.

Its superior excellence for fuel, together with its value as hard, strong timber for all purposes where firmness and strength are required, together with its many qualities as an ornament, render it the most desirable of all deciduous trees for general planting.

LARCH.

Mr. Lapham says: The larch is a coniferæ, though the leaves are deciduous, in autumn. It is a tall, slender grower, with heavy, coarse-grained, durable and valuable wood, wherever light, straight timber, such as hoop-poles, is required. The trees should be cut in the winter, and the bark stripped off in the spring. Unless this be done the poles will soon decay from retaining moisture under the bark. It is also a valuable wood for fuel, but burns rapidly, and with great heat, being much used for puddling iron, and in other places where a hot flame is required. It grows naturally on low, wet, even swampy grounds, in all the northern states and Canadas; yet it flourishes far better when brought out and planted in dryish soil. When the American larch is planted on such land and tended the same as the European or Scotch larch, it grows much more rapidly than in its native swamps. Those who desire to make plantations of the larch, should take into consideration the character of the land to be planted; if it be wet, then the American larch should be chosen. The large trees can be sawed into good boards, plank and other sawed timbers, or be hewed into large building timbers, for which purposes it is eminently adapted. The larch makes excellent piles for docks, or for the foundation of buildings in wet grounds. That it will last for ages we have abundant proof. Larch piles have been taken up where it is positively known that they have been driven more than a thousand years, and yet they were sound and uninjured. So too, larch logs have been dug from peat bogs "buried 12 to 15 feet deep and where they must have been buried before the adamic period, and yet such logs were sufficiently sound to be cut into timber."

My father in Wrightstown, Wisconsin, three or four miles back from the Fox river, in digging a well found at the bottom, about 15 feet below the surface, a tamarack log as sound as the day it fell. The entire 15 feet above is solid red clay. Several such discoveries have been made in that neighborhood at depths ranging from 12 to 20 feet. These facts show that larch is very durable, nay, almost indestructacable. It far excells cedar for fence posts, is equally durable, provided the sap be hewn off the portion set in the ground, and is far superior for holding nails.

Notwithstanding the much that may be said in favor of the European larch, we must say with Mr. Bates, that the American larch is "every way superior."

Upon the value of larch I give an extract from Mr. Bates, of Chica-

go, in his paper, upon the "*Ship timber of the United States*:"

"*Hackmatack* or *tamarack* is the American larch. It is a very important wood to the ship-builder, every way superior to the European larch, and is becoming rare in the United States. In the British provinces it is a flourishing tree, not unfrequently found growing on hard and dry soil, and of superior quality; but in the United States the hackmatack is confined in its growth principally to the swampy parts of the pine districts of the northern States. The timber is not large, but well adapted to the top and deck framing of vessels. It is also used for ceiling, beams, and stanchions: and the roots for knees, breast-hooks, sharf-floors, and futtocks are excellent. For lightness, strength, tenacity, and durability combined hackmatack is unequalled. It is cheaper in price than any other standard timber. Vessels have been built of hackmatack in every part. The extreme stiffness of the planks was modulated for bending by the use of steam in the customary way, except that a moderate quantity of fish oil was supplied in the boiler for the purpose of aiding to soften the wood.

Hackmatack is more tenacious of spike or square bolt iron fastening than most kinds of oak, and weight for weight in the green state, or half seasoned, is considerably stiffer and stronger than white oak. This is due, no doubt, to the gummy nature of the wood, as well as to the closeness and compactness of its fibre. The sap-wood should be excluded in building; the heart-wood requires no seasoning before use, as the shrinkage in weight in seasoning is less than two pounds per cubic foot. It affords very good treenails for fastening soft wood planks.

One of the principal advantages of planting larch, is its adaptation to localities valueless for any other purpose. There is throughout the west a vast amount of low lands comparatively valueless for anything else, unless it is black ash. River bottoms, and swamp lands overflowed a good part of the year, will produce rapid and valuable growth of larch.

One of the principle objects in forest tree culture is to obtain timber for fences, farm buildings and implements; for these purposes, without special reference to ornament, we have seen, when considering the growing from the seed—(Chapter III,) that no timber tree yields so valuable a return in so short a time as American larch.

Arbor vitæ, (*white cedar*,) grows naturally in swamps and in cool, rocky localities. It is frequently seen growing out of the clefts of perpendicular rocks hundreds of feet from the ground with its roots cropping out of the crevises and reaching far down for soil and nutriment. In this vicinity (northern Wisconsin,) it grows in extensive "cedar swamps" and mingled a little with spruce, larch and Balsam fir, sometimes so thickly as to be almost impassible, reaching the height of 60 to 100 feet, and sometimes three feet in diameter. From these native swamps vast quantities of fence posts and telegraph poles are shipped every year.

This county (Door) alone will furnish Chicago market at least 1,000,000 fence posts, besides a very large quantity of telegraph poles, during the shipping season of 1869.

Arbor vitæ is a moderate grower, makes an excellent hedge or wind brake, grows well on any kind of soil, is hardy and easily transplanted—bears the sheers well; I have seen them in yards cut to egg shape, a suc-

cession of globes and various fantastic forms.

This tree is rapidly propagated from cuttings planted in frames early in autumn and protected from frost in winter. In making cuttings it is best to take the young wood with a small portion of the old wood attached. The soil in which they are planted should be at least one-half sand or sandy loam, and the remainder a good, well decomposed leaf mould, or other old and rich soil. If planted in September or early October, they will usually be rooted by the first of May following, even when no glass is used for coverings. They should be shaded from the direct rays of the sun until winter; and then covered sufficiently to keep out frost, and they are ready to transplant the next spring. The seeds ripen in the fall and should be gathered immediately after the frost is out of the catkins, and should be kept cool and moist until the following spring, when they may be planted in beds.

Red Cedar (*or Savin.*)

Mr. Lapham says of it:

The red cedar wood is well known as one of the most durable. It is laid down in the books, that the tree is one of the slowest in growth. This statement may be true in the eastern states, or generally; but is far from true in Wisconsin. Trees may be seen in Madison, and other towns of the state, which were taken from the banks of the lakes, twelve or fifteen years ago, and which at that time were not more than three feet high, and an inch in diameter, and planted in the yellow and richer soil, where the hickory and black jack oaks flourished, and which are now fifteen feet high, and ten to twelve inches in diameter. In fact, they have grown about as fast as the sugar maples and white oaks, in the same situation. In the city of Janesville and its vicinity, trees may be seen, which in fourteen or fifteen years from seeds have grown into trees twelve inches in diameter at the butt, and twenty-five feet high, even out-growing the Scotch pine which stands near them.

We have no tree which will endure as great changes in climate, wet and dry, hot and cold, as the red cedar. It will find its root-hold on the ridges and cliffs of rocks, and is the first tree one meets as he approaches the Rocky mountains, after crossing the treeless plains, where it stands on the dry hill side, or hangs in the cliffs of the rocks, where scarcely any other vegetation is found; and it may be found in the wet sands of the islands of the Wisconsin river and other streams. It is one of the densest of our evergreens, and is the very best tree to oppose to the full blasts of the storms and winds of both summer and winter, in the most exposed situations. For posts to set in the ground there is no tree which lasts so long; and even if it do take years to grow it to sufficient size for posts, it will last until another tree may be grown, if the seed be planted when the post is set.

It may be propagated from cuttings under glass; but the safest way is to make use of seeds. These may be gathered in autumn, and mixed with muck or leaf mould and placed in the open ground until they germinate, which often takes two years. Some bruise the berries so as to break the resinous coverings and then the seeds come up the first year.

PINE—NORWAY PINE—(RED PINE.)

This species of pine grows sometimes very large, tall, straight and smooth, sometimes reaching nearly 100 feet in height, without a branch.

My brother has prepared for shipping to Chicago market, 400 city telegraph poles, of Norway pine, 55 feet long, 12 inches at butt and 8 to 10 at top, many of them as straight and true as if they had been turned. Next to the white pine this is the most desirable species of pine. It is quite difficult to transplant because of its having so few fibrous roots. Transplanting it should never be attempted, except with very small plants. "As an ornamental tree its dark green foliage and long leaves make it rank above the Austrian pine, which it much resembles, and excels in growth."

WHITE PINE.

This is the largest and tallest of all our native trees, sometimes attaining a size of 4 to 6 feet diameter and raising 160 feet, and almost perfectly straight, one-half of which is clear of limbs. I have seen spars cut from our forests here 95 feet long and worked as straight as a line, 20 inches square at top, and 3 feet diameter at base. No other tree yields such invaluable lumber which in the large trees is nearly free from resin; it is the easiest and smoothest timber to work under the plane we have; yet in durability it vies with the oak. When growing in the openings it is a beautiful dense cone topped tree, well adapted for screens and wind-breaks. When massed thickly for timber belts at the rate of 600 to 800 trees to the acre, it mounts upward with the most rapid growers.

The white pine is not so difficult to transplant as the Norway—both these varieties grow very rapidly, keeping pace with most deciduous trees, to which they are good neighbors. The pine cone opens in early winter and drops its seeds; they should be kept cool until the following spring and planted.

HEMLOCK—(WEEPING SPRUCE.)

This is a large tree, and most graceful of all the spruce family, almost rivaling the pine, when all its parts are considered. The bark is the most valuable material for tanning we have, and is the main dependence of the tanners. The timber is coarse-grained, holding nails remarkably well, and of first quality for scantlings, joice and building timber. Immense quantities of the smaller trees are hewn into railroad ties. It will grow very thickly on good soil 1500 trees to the acre, and prefers a light, dry, sandy or rocky soil. There is no difficulty in growing it on any soil except on a heavy clayey soil where it is liable to winter-kill. Its rapidity of growth nearly equals the pine. It makes the most beautiful and dense hedge or wind-break of any thing we have.

This is really the most beautiful native evergreen we possess; and great quantities should be grown in all parts of the prairie country.

These great families of trees, (pines and hemlock) have played a very important part in the economy and advancement of the country. We are apt to overlook the chief value of these trees, and their timber in planting forests or shades, because they do not hold out such great pecuniary advantages in so short a time as do some others. Although they grow as rapidly and their wood is as valuable, yet it takes longer for it to

attain the greatest value in a single tree. Other trees are cut when small--so are some of these,—hemlock for instance for railroad ties, but the best are chiefly used for boards and plank, timber and shingles, require large trees grown in shaded situations, so as to be free from knots and crooks, and have a good length of trunk.

The evergreen forests of Wisconsin have been and still are more valuable than placers of gold in the gulches of the Rocky mountains, if we simply count the dollars which the lumbermen have extracted from them by the aid of toil and machinery.

The pines of this State have contributed materially to build cottages and palaces, not only in this State, but in all the States washed by the Mississippi and Lake Michigan. Scarcely a dwelling, church, schoolhouse, public or private building can be found, to which they have not contributed more or less. The plentifulness of the timber has hitherto kept down the price, and it has not been appreciated. Great forests have been robbed of their best trees, for the sake of a single log, or a few shingle-bolts; other trees and forests have been wantonly destroyed. The young trees, designed by Providence to replace the old, have been ruthlessly cut away to make a place for an experiment in growing corn on sands so destitute of vegetable matter, that corn could not grow, until the pines had for ages more shed their needle-shaped leaves on the barren surface.

It would seem as if the woodman, axe in hand, had found himself in the midst of the dense evergreen forest, and forgetting all of earth beside, and because his visions was bounded by the trunks and branches of large trees, he believed all the world was pine; and that fate had placed him there to hew out an opening, and let in the light of the sun; that the quantity and extent were what they appeared to his limited vision—infinitely large and therefore inexhaustable. His vision could not extend just over the tree tops, within the day's flight of the pigeon, where was spread out a region far greater than his forest, on which no tree rears its head, and where all and more than all, the trees which surround him, are wanted for its use.

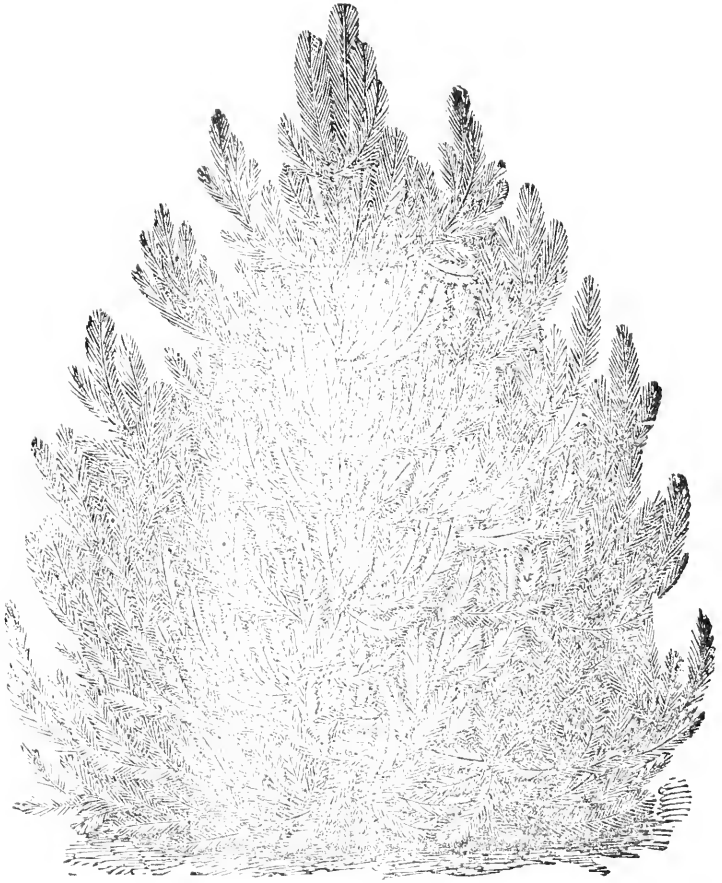
The time has already arrived when we begin to feel that there is a scarcity of pine timber; where it was but a few years ago, sold for $10 for a 1,000 feet, it now readily brings thrice its former prices, with no prospect of being any cheaper.

This increase is not owing to a scarcity of labor, as some tell us, or to an increase of currency, as others say. Although these causes may have some effect at present, yet it is mainly owing to the difficulty in getting the trees from which the lumber is made, which has raised the price. In a few years more, if lumber continues to advance, and there is no reason why it should not, it will be beyond the reach of the poor, or even the middle classes, and these must resort to other materials from which to construct their abodes; and as in Europe with no intermediate material between mud and stone walls, the rich will live in this, the poor in that.

The rapid strides which we have made in advancement, may be attributed as much to the cheap pine lumber as to the enterprise and intelligence of the people expended upon the prolific soil of the State. This

cheap lumber has built our houses and our barns, our stores and fences, and given to the people their long stride in the race of nations. But while those trees have been destroyed to build a State, no efforts are made to replace them with others; on the contrary, if the young trees are not broken down and killed, the fire is allowed to run over the land and complete the devastation man had commenced; whereas, if they had received proper care and attention, the forests of evergreens now cut down and gone, would in 40 or 50 years have been replaced with another nearly equal to the first.

If in planting belts and groves of trees for timber, shelter or protection from winds, a free use were made of such evergreens as would thrive on the soil occupied, they would grow all the better for admixture; and within a lifetime, the pines would become saw logs, and the cedars split into fence-posts. Retaining their foliage during winter, they afford protection at a time when it is most needed. A belt of these surrounding a farm, mingled with others, or alone, or at least such portions as contains the buildings, orchard and garden, gives a cheerful, comfortable appearance to the place; and both man and beast will live longer and be more comfortable and happy than when exposed to every gale of winter, when for more than six months of the year nothing appears life-like—nothing to break the force of the blast as it comes over drifting snows. If they take room, and shade the ground, they shelter while they live, and pay a large rent in timber when they die. Cherish them as good friends.



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